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Updated Stratigraphic Selections for Wells in the Vicinity of the Subsurface Disposal Area

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ABSTRACT

This report documents the review and selection of the values for the stratigraphy database of surficial sediment and interbed elevations and thicknesses beneath the Subsurface Disposal Area at the Radioactive Waste Management Complex. The database forms the basis of contaminant transport modeling that supports the remedial investigation and feasibility study for Waste Area Group 7, Operable Unit 7-13/14.

EXECUTIVE SUMMARY

This report improves the documentation for lithologic selections to use in future simulations of groundwater transport beneath the Subsurface Disposal Area (SDA), a radioactive landfill in the Radioactive Waste Management Complex (RWMC), located within the Idaho National Engineering and Environmental Laboratory. The report accomplishes this through (1) reviewing the types of borehole data upon which stratigraphic selections are made to delineate between the sedimentary and basalt portions comprising the subsurface lithology of the SDA, (2) explaining how these data were used to determine borehole stratigraphy beneath the SDA, (3) tabulating the lithologic selections for each well in the vicinity of the SDA with references to the data used for those selections, and (4) identifying differences between these updated selections and those previously published in Table 5-9 of the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (ABRA) (Holdren et al. 2002).[a] This report will support the remedial investigation and feasibility study for Waste Area Group 7, Operable Unit 7-13/14.

Documented in this report are the following:

- The basis for the lithologic selection for each well in the vicinity of the SDA

- Confirmation of the correct transcription of the United States Geological Survey (USGS) report (Anderson et al. 1996)[b] lithologic selections into the database that serves as the basis for describing variable lithology in the SDA vicinity

- Documentation of the lithology selections for all completed wells in the vicinity of the SDA that are not included in the USGS report.

This report identifies data sources for every well and makes new depth and interval determinations for some wells using simplified borehole geophysical logs. Overall, the new stratigraphic selections are not significantly different from the Table 5-9 selections in the *Ancillary Basis For Risk Analysis of the Subsurface Disposal Area* (Holdren et al. 2002).

The interpretation method used by the USGS (Anderson et al. 1996) to develop a lithologic framework is still the best approach for understanding the RWMC area stratigraphy: the USGS lithologic selections will not be improved by rechecking Anderson's extensive work. The USGS model has been affirmed both by other researchers within the USGS and by outside researchers.

Based on that affirmation, the SDA stratigraphic database, as presented in Holdren et al. (2002), was verified, validated, and updated. The initial step in verifying and validating was to ensure that USGS data (Anderson et al. 1996) were correctly transcribed into Table 5-9 of Holdren et al. (2002). Then the following additional criteria were applied for wells not included in the USGS report:

- Making independent selections for interbed depths and thicknesses in the wells that have continuous or partial borehole geophysical logging data

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a. Holdren, K. J., B. H. Becker, N. L. Hampton, L. D. Koeppen, S. O. Magnuson, T. J. Meyer, G. L. Olson, and A. J. Sondrup, 2002, *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area,* INEEL/EXT-02-01125, Rev. 0, Idaho National Engineering and Environmental Laboratory.

b. Anderson, S. R., D. J. Ackerman, M. J. Liszewski, and R. M. Freiburger, 1996, *Stratigraphic Data for Wells at and near the Idaho National Engineering Laboratory, Idaho*, DOE/ID-22127, Open-File Report 96-248, U.S. Geological Survey.

- Making independent stratigraphic selections for interbed depths and thicknesses in the wells that do not have continuous or partial borehole geophysical logging data, relying solely on lithology logs where no other information was available.

The resulting modifications to the SDA stratigraphy database are documented in summary tables in the appendixes to this document.

A companion document to this report compiles and summarizes all well information for the Radioactive Waste Management Complex (Whitaker 2004)[c].

c. Whitaker, C. A., 2004, *Stratigraphic and Geophysical Data for Wells in the Vicinity of the Subsurface Disposal Area*, ICP/EXT-04-00208, Rev. 0, Idaho National Engineering and Environmental Laboratory.

ACKNOWLEDGMENT

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ACRONYMS

ABRA	Ancillary Basis For Risk Analysis of the Subsurface Disposal Area
INEEL	Idaho National Engineering and Environmental Laboratory
NGR	natural gamma ray
OU	operable unit
RI/FS	remedial investigation and feasibility study
RWMC	Radioactive Waste Management Complex
SDA	Subsurface Disposal Area
USGS	U.S. Geological Survey
WAG	waste area group

Updated Stratigraphic Selections for Wells in the Vicinity of the Subsurface Disposal Area

1. INTRODUCTION

This report improves the documentation for lithologic selections to use in future simulations of groundwater transport beneath the Subsurface Disposal Area (SDA), a radioactive landfill in the Radioactive Waste Management Complex (RWMC), located within the Idaho National Engineering and Environmental Laboratory (INEEL). The report accomplishes this through (1) reviewing the types of borehole data upon which stratigraphic selections are made to delineate between the sedimentary and basalt portions comprising the subsurface lithology of the SDA, (2) explaining how these data were used to determine borehole stratigraphy beneath the SDA, (3) tabulating the lithologic selections for each well in the vicinity of the SDA with references to the data used for those selections, and (4) identifying differences between these updated selections and those previously published in Table 5-9 of the *Ancillary Basis for Risk Analysis of the Subsurface Disposal Area* (ABRA) (Holdren et al. 2002). The updated data will support the remedial investigation and feasibility study (RI/FS) for Waste Area Group (WAG) 7, Operable Unit (OU) 7-13/14.[d]

Examination of the lithologic database on which the risk and contaminant transport models were based is necessary because of the following:

- Interbed depth and thickness selections or values in the WAG 7 stratigraphy database originated from various sources

- Some of the sources were not referenceable

- The origin of the stratigraphic selections (i.e., whether from lithologic logs, geophysical logs, or a combination of both) was not clear.

1.1 Overview

Thicknesses and depth of sedimentary features strongly control subsurface transport of contaminants. Consequently, these features also affect the numerical simulations of the groundwater pathway modeled for OU 7-13/14. A series of simulation studies conducted for OU 7-13/14 since 1993 have ranged from simplistic conservative models treating spatially variable lithology as averaged layer-cake geology (Burns et al. 1994) to more representative models that account for spatially variable lithology (Holdren et al. 2002).

The OU 7-13/14 project determined that documentation needed to be improved for the lithologic selections to aid future OU 7-13/14 modeling. Prior to this task, the lithologic selection documentation consisted of Table 5-9 of the ABRA (Holdren et al. 2002). Documentation was available for the selections from Table 5-9 originating from a U.S. Geological Survey (USGS) report (Anderson et al.1996) and for selections from well completion diagrams containing lithology logs from well completion reports for wells that were not included in that USGS report, or for wells that were drilled after that USGS report was

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d. The Federal Facility Agreement and Consent Order lists 10 WAGs for the INEEL. Each WAG is subdivided into OUs. The RWMC is identified as WAG 7 and originally contained 14 OUs. Operable Unit 7-13 (transuranic pits and trenches RI/FS) and OU 7-14 (WAG 7 comprehensive RI/FS) were ultimately combined into the OU 7-13/14 comprehensive RI/FS for WAG 7.

completed. However, no documentation was available for lithologic selections based on natural gamma logs for numerous wells that were included in Table 5-9.

Documented in this report are the following:

- The basis for the lithologic selection for each well in the vicinity of the SDA
- Confirmation of the correct transcription of the USGS report (Anderson et al.1996) lithologic selections into the database that serves as the basis for describing variable lithology in the SDA vicinity
- Documentation of the lithology selections for all completed wells in the vicinity of the SDA that are not included in the USGS report.

This report identifies data sources for every well and makes new depth and interval determinations for some wells using simplified borehole geophysical logs. Overall, the new stratigraphic selections are not significantly different from the Table 5-9 selections in the ABRA (Holdren et al. 2002).

A companion document to this report compiles and summarizes all well information for the Radioactive Waste Management Complex (Whitaker 2004).

1.2 Purpose and Scope

The purpose of this report is to document lithologic selections, based on three primary data sources, for the database forming the geologic framework used in support of the OU 7-13/14 RI/FS. Specifically, this report verifies and validates the surficial sediment and the A-B, B-C, and C-D interbed elevations and thicknesses beneath the SDA as presented by the USGS report (Anderson et al.1996). It also documents changes to other entries in Table 5-9 of the ABRA and documents new lithologic selections for wells completed since publication of the ABRA (Holdren et al. 2002). These data collectively constitute a database of the geologic framework of risk and contaminant transport models for WAG 7, OU 7-13/14.

1.3 Document Organization

The following briefly describes the remaining sections in this report:

- Section 2 provides a brief history and description of the SDA
- Section 3 evaluates the three primary lithologic selection data sources and establishes the protocol for making updated lithologic selections for wells not addressed in the USGS report
- Section 4 summarizes results from the application of the selection protocol to wells for which the USGS did not make lithologic selections
- Section 5 lists the references cited throughout this report
- Appendix A contains a detailed table listing the original values for each lithologic unit in each well and revised results where changes are being made

- Appendix B summarizes the information in Appendix A and contains the updated lithologic database that will be used for supporting contaminant transport modeling at the SDA

- Appendix C contains the geophysical logs for SDA vicinity wells

- Appendix D contains the well completion diagrams for SDA vicinity wells.

2. SITE BACKGROUND

The INEEL, originally established in 1949 as the National Reactor Testing Station, is a Department of Energy-managed facility that has historically been devoted to energy research and related activities. The name was changed to the Idaho National Engineering Laboratory in 1974 to reflect the broad scope of engineering activities taking place at various on-Site facilities. In 1997, the name was changed again to the Idaho National Engineering and Environmental Laboratory to be consistent with contemporary emphasis on environmental research.

The INEEL is located in southeastern Idaho and occupies 2,305 km^2 (890 mi^2) in the northeastern region of the Snake River Plain. Regionally, the INEEL is nearest to the cities of Idaho Falls and Pocatello and to U.S. Interstate Highways I-15 and I-86. The INEEL Site extends nearly 63 km (39 mi) from north to south, is about 58 km (36 mi) wide in its broadest southern portion, and occupies parts of five southeast Idaho counties. Public highways (i.e., U.S. 20 and 26 and Idaho 22, 28, and 33) within the INEEL boundary and the Experimental Breeder Reactor I, which is a national historic landmark, are accessible without restriction. Otherwise, access to the INEEL is controlled. Neighboring lands are used primarily for farming or grazing, or are in the public domain (e.g., national forests and state-owned land). See Figure 1 for the location of the INEEL and of the major facilities.

2.1 Site Description

The RWMC, located in the southwestern quadrant of the INEEL, encompasses a total of 72 hectares (ha) (177 acres) and is divided into three separate functional areas: the SDA, the Transuranic Storage Area, and the Administration and Operations Area. The original landfill, established in 1952, covered 5.2 ha (13 acres) and was used for shallow land disposal of solid radioactive waste. In 1958, the landfill was expanded to 35.6 ha (88 acres). Relocating the security fence in 1988 to outside the dike surrounding the landfill established the current size of the SDA as 39 ha (97 acres). The Transuranic Storage Area was added to RWMC in 1970. Located adjacent to the east side of the SDA, the Transuranic Storage Area encompasses 23 ha (58 acres) and is used to store, prepare, and ship retrievable transuranic waste to the Waste Isolation Pilot Plant. The 9-ha (22-acre) Administration and Operations Area at RWMC includes administrative offices, maintenance buildings, equipment storage, and miscellaneous support facilities. See Figure 2 for a map of RWMC showing the location of the SDA.

The Eastern Snake River Plain aquifer underlies RWMC at an approximate depth of 177 m (580 ft), and generally flows from the northeast to the southwest. The aquifer is bounded on the northwest and southeast by the edge of the Snake River Plain, on the southwest by surface discharge into the Snake River near Twin Falls, Idaho, and on the northeast by the Yellowstone plateau. The aquifer is hosted in the fractured and layered basalt flows of the Eastern Snake River Plain.

The regional subsurface consists mostly of layered basalt flows interbedded with comparatively thin sediments. Layers of sediment, referred to as interbeds, tend to retard infiltration to the aquifer and are important features in assessing the fate and transport of contaminants. In the 177-m (580-ft) interval from the surface to the aquifer, three major interbeds are of particular importance. Using nomenclature established by the USGS, these sedimentary layers are referred to as the A-B, B-C, and C-D interbeds.

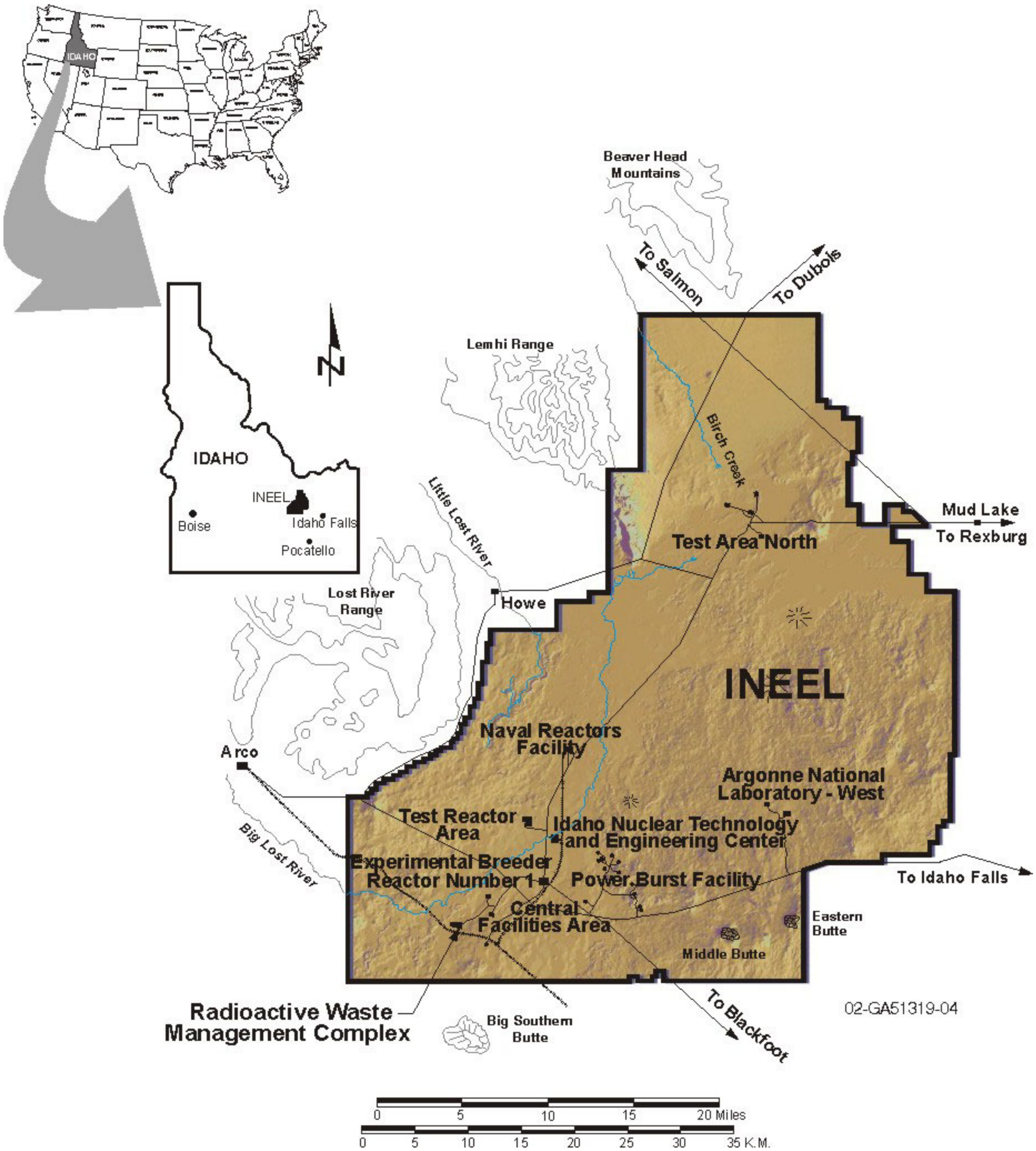

Figure 1. Map of the Idaho National Engineering and Environmental Laboratory showing the location of the Radioactive Waste Management Complex and other major facilities.

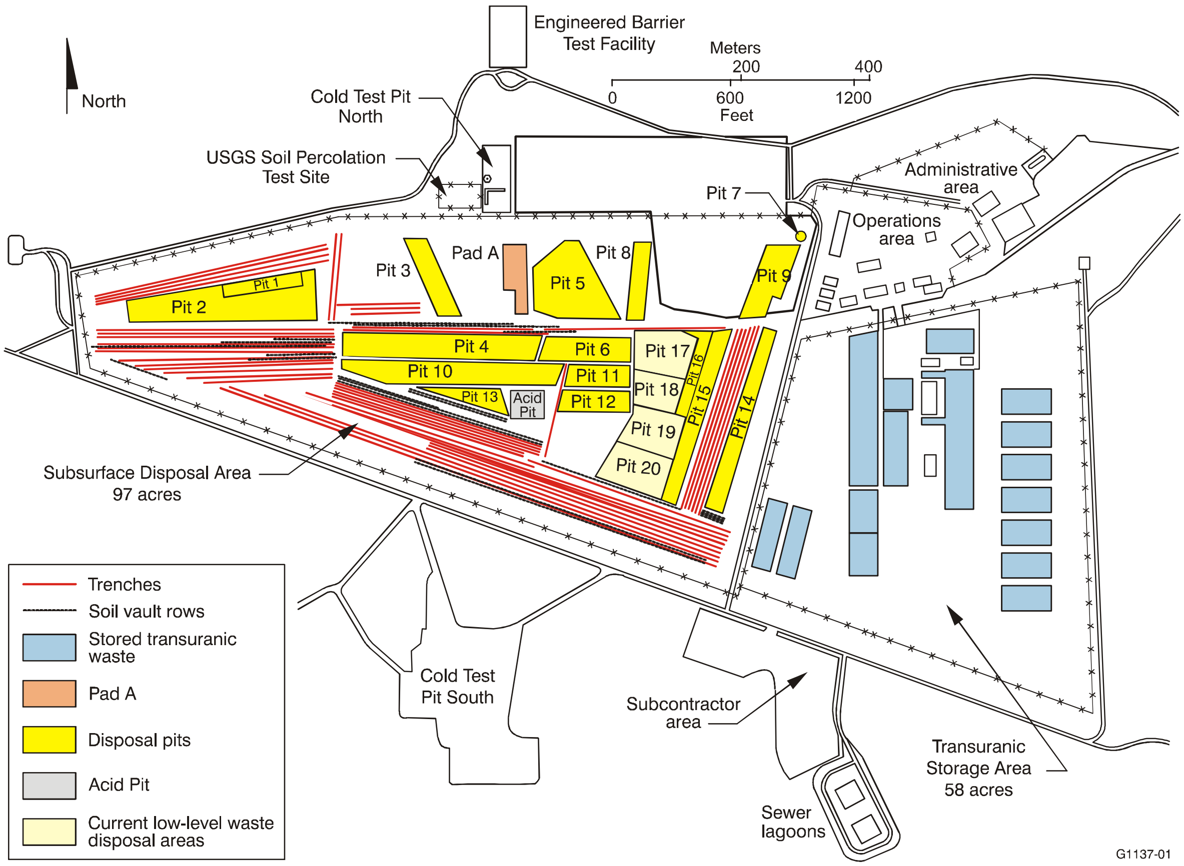

Figure 2. Map of the Radioactive Waste Management Complex showing the location of the Subsurface Disposal Area.

3. EVALUATION

The following three primary sources of surficial sediment and interbed data were examined:

- Stratigraphic selections for wells by the USGS (Anderson et al.1996)
- Natural gamma borehole geophysical logs for wells that were not evaluated by the USGS report or were drilled after 1996
- Lithologic logs for wells that were not evaluated by the USGS report or were drilled after 1996.

A total of 140 wells, each penetrating at least through the surficial sediment, were used to obtain information on lithology in the vicinity of the SDA (Figure 3).

3.1 U.S. Geological Survey Stratigraphic Interpretations

The USGS based the RWMC stratigraphy on logs of continuous cores collected from seven coreholes at RWMC; three of these were deep enough to penetrate into the aquifer and one penetrated to 1,800 ft below land surface (Anderson et al. 1996). The core logs and the natural gamma ray (NGR) logs corresponded closely; the few necessary depth corrections were minor and systematic. No recent lithologic logs are as good or as detailed as the core logs used by the USGS report to establish stratigraphic framework.

The interpretation method used by the USGS to develop a lithologic framework is still the best approach for understanding the RWMC area stratigraphy; the USGS lithologic selections will not be improved by rechecking Anderson's extensive work. The USGS model (Anderson et al.1996) has been affirmed both by other researchers within the USGS (e.g., Barraclough et al. 1976) and by outside researchers (e.g., Hughes, McCurry, and Geist 2002; Blair 2002).

3.2 Natural Gamma Logs

The USGS approach documented in Anderson et al. (1996) demonstrated that the geophysical logs, especially the NGR data, provide the most detailed and accurate means of establishing borehole lithologic selections. Following the USGS example, it is the geophysical logs, and the NGR log in particular, that reveal the greatest and most accurate stratigraphic detail as to the location and thickness of interbeds. Qualitative evaluation of NGR logs depends on "shape-matching" distinctive patterns shared by the geophysical signature in two or more boreholes. This method relies on good contrast between basalt "marker beds" (i.e., other basalts) and between basalts and interbeds. Shape-matching qualitative NGR logs for stratigraphic correlation has been successfully employed by researchers in a variety of basalt provinces, including the Columbia River Plateau (Crosby and Anderson 1971; Siems 1973; Siems, Bush, and Crosby 1974) and the Deccan Traps in India (Buckley and Oliver 1990; Versey and Singh 1982). At the RWMC, the distinctive NGR pattern of the interbeds makes it relatively easy to establish stratigraphic correlations. Patterns of NGR-response for basalt marker beds and sedimentary interbeds are not affected by changes in instrumentation and instrument gain, even when the data span 50 years and several generations of logging equipment.

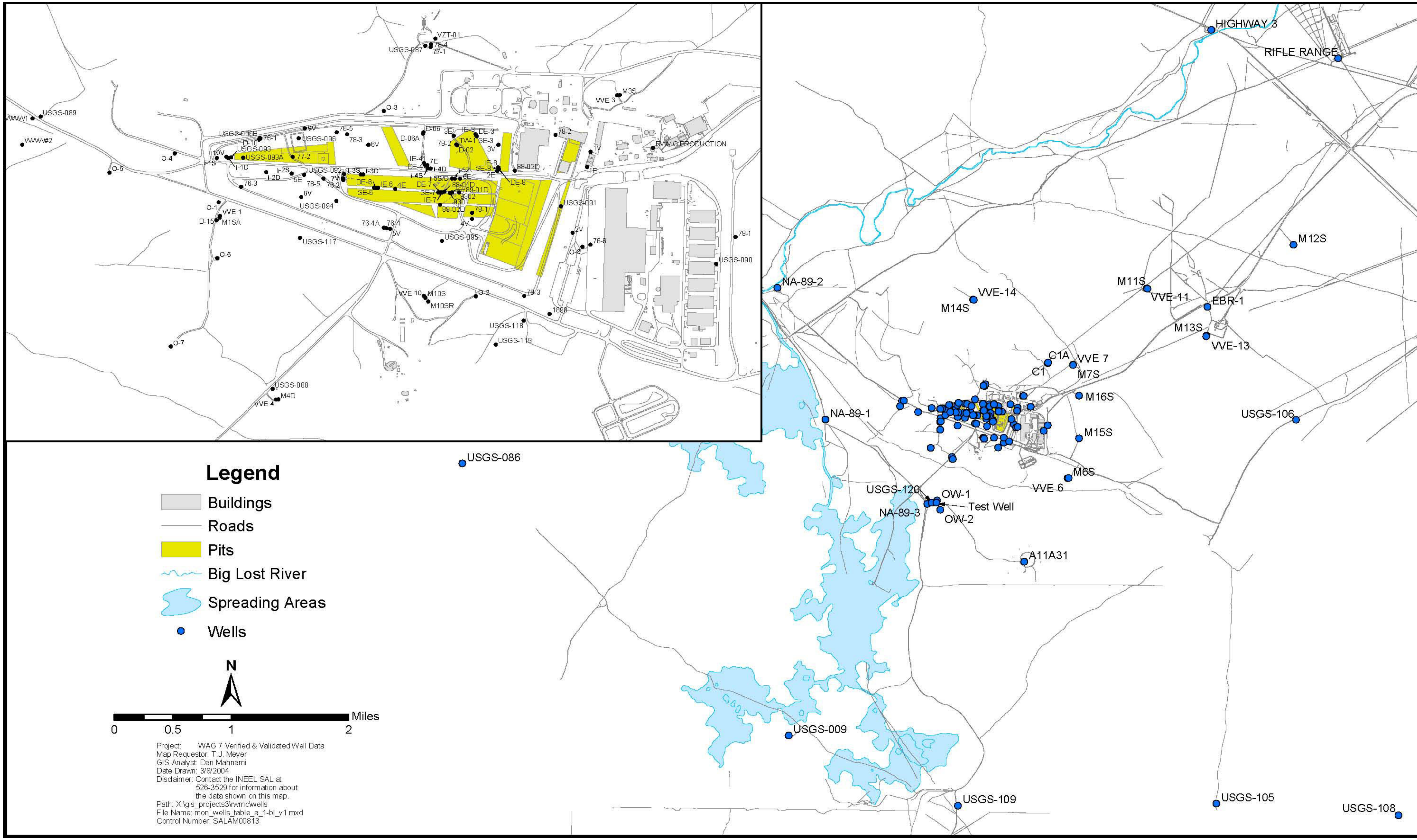

Figure 3. Locations of wells deeper than the surficial sediments that were used to obtain lithology information.

3.2.1 Quality of Natural Gamma Logs

Most NGR logs at the INEEL were not collected using calibrated equipment. Some limited descriptions of older logging tools used at the INEEL can be found in USGS reports published before 1970 (e.g., Chase et al. 1964; Keys 1963). All the NGR tools used at the site have used some form of a standard scintillation counter for the detection of naturally emitted gamma rays. Using NGR data from five generations of logging equipment is not an impediment to using these logs for qualitative stratigraphic analysis. The only demonstrable difference between successive generations of NGR tools used on the site is one of instrument gain. The amount of emitted gamma rays from the rocks in the borehole wall will not change over the short periods of time the INEEL NGR logs have been collected. The only changes are the sensitivity of the detectors on the NGR tools and modifications to well construction.

A comparison of NGR logs from different generations of tools shows that NGR measurements vary linearly from one another. Figure 4 shows NGR logs for USGS-29 collected by three different generations of NGR tools. The legend for Figure 4 lists the collection date of the log. Regardless of the changes of tools and instrument gain, the shape pattern of the sediment peaks and basalt marker beds is preserved.

3.2.2 Precision and Accuracy of Depth Selections Based on Natural Gamma-Ray Logs

In general, depth estimates (i.e., peak half-heights) from NGR logs at the INEEL are internally precise but often lack accuracy because few INEEL NGR logs documented the depth reference used during logging. For example, logs can be referenced to any number of features, including ground surface, casing lip, or benchmark. In addition, the tops of many older wells were rebuilt in the 1980s and early 1990s, but there is often no documentation as to whether a depth reference point was added or modified (e.g., adding a bench mark or concrete well pad, or changing the height of a nested casing). This uncertainty regarding depth reference points affects the adjustment of depths between NGR logs from the same well, some of which have depth discrepancies of 5 ft or more between them.

Figure 5 shows two original and unmodified NGR logs collected in well M17S. Lack of documentation as to the depth references used for these two logs results in a lack of accuracy for any M17S depth selection. These two logs illustrate the problem of uncertainty in the choice of depth reference point. Regardless, the replicability of the M17S NGR logs is excellent, both in terms of shape and in terms of the distances between units in the subsurface. This combination of high precision but poor accuracy for depth selections is typical of NGR logs at the INEEL.

There are two other sources of inaccuracy: (1) a potential systematic depth error of approximately 3.5 ft introduced by the USGS-mandated nationwide topographic map conversion from the 1929 elevation datum to the 1988 elevation datum and (2) error introduced when a borehole has deviated from the vertical while drilling. The error in depth because of deviation can be 2 ft or greater at approximately 500 ft below land surface (Rohe and Studley 2003).

NGR logs are replicable and precise, including the thicknesses of flows and interbeds. However, because of poorly documented reference points, depth estimates to subsurface units are often inaccurate.

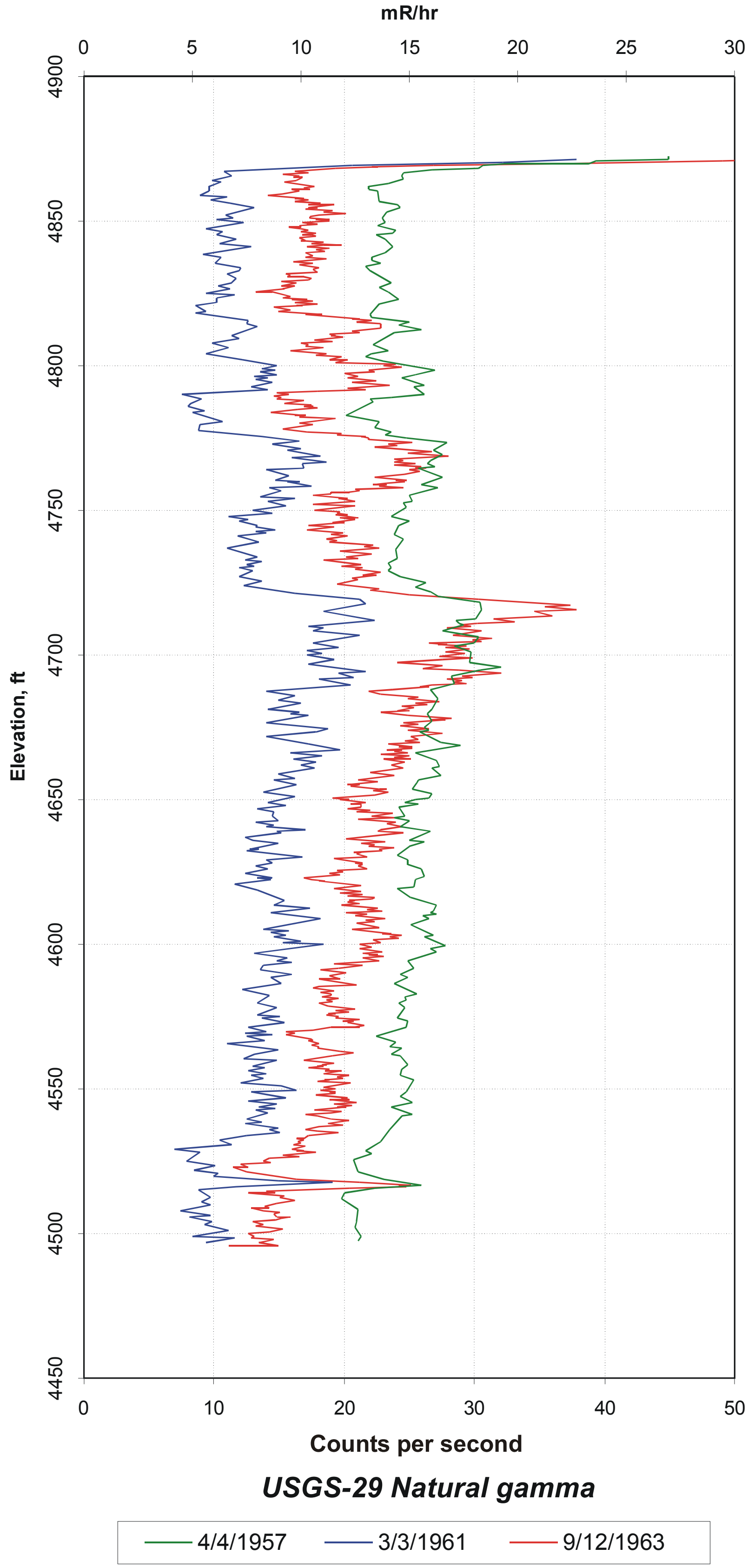

Figure 4. A comparison of natural gamma-ray logs from different generations of tools.

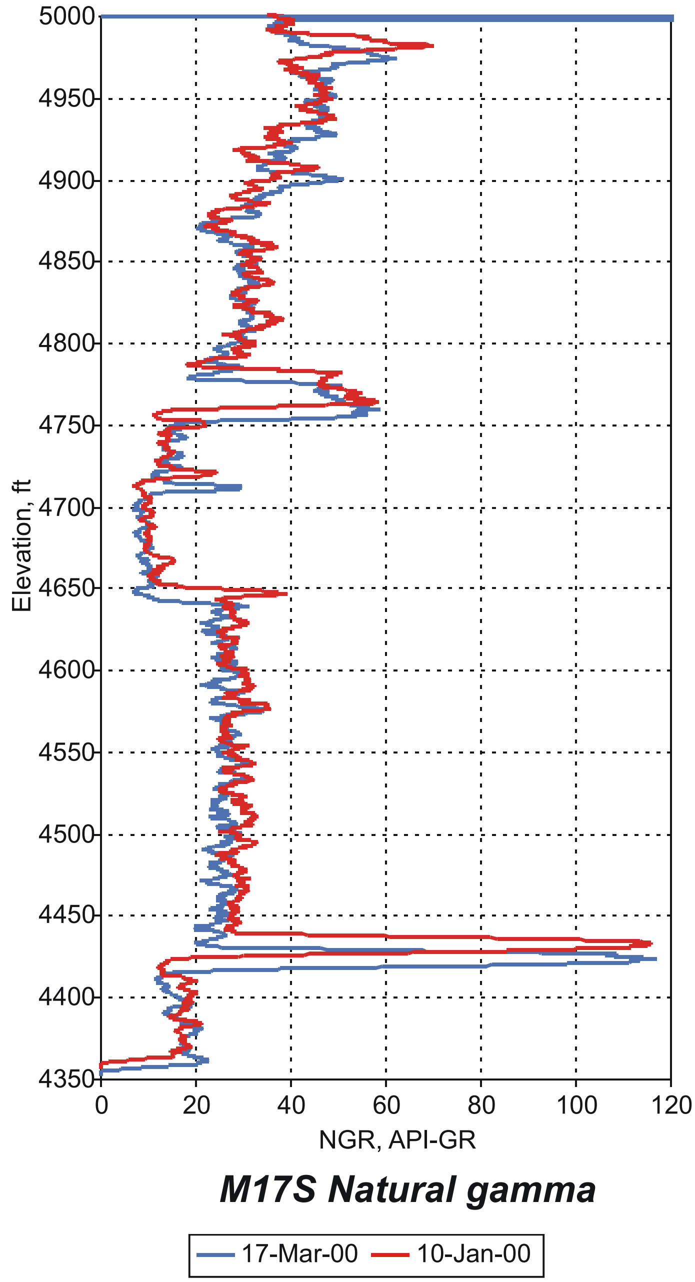

Figure 5. Logs of M17S showing uncertainty in the choice of depth reference points.

3.3 Lithology Logs

3.3.1 Quality of Lithology Logs

Many lithology logs compiled in the 1950s and 1960s are superior to many modern lithology logs, both in the resolution of units and in the quality of description. This is especially true of older logs based on chips recovered by bailer on cable-tools rigs (e.g., Jones and Jones 1952). The quality of a lithology log is usually determined by comparison with available NGR logs and other lithology logs for the same borehole. Many NGR and lithology logs do not match in compiled USGS reports such as Chase et al. (1964) or Keys (1963). Chase et al. (1964) acknowledge this problem, discuss the variable quality of lithology logs, and note that the lithology logs will require correction to reconcile them to NGR logs: a less than satisfactory outcome since it calls into question the quality of all simplified or modified lithology logs. Regardless, many USGS reports do present the original unmodified lithology logs without biasing them by simplification (e.g., Jones and Jones 1952); however, even original lithology logs can be mismatched in both depth selections and lithology in comparison to their associated NGR logs.

A survey of INEEL lithology logs often reveals two or more lithology logs for a given borehole or well and a field log of variable quality. The lithology logs taken in the field can be very detailed (e.g., TRA-4). Some lithology logs and well completion diagrams may also be simplifications of more detailed information. The motivation for simplifying lithology logs is to fit them on one page with their associated NGR logs and well construction information. Some simplified lithology logs are of limited value. Others are very detailed (e.g., C1A) (Knutson, Sullivan, and Dooley 1993). Few, however, can be reconciled to NGR logs without adjustments for depth.

The only lithology log as precise as an NGR log is one based on cores. If cores are taken continuously starting at ground surface, then a lithology log based on these cores will be more accurate with respect to depth than a log based on chips or cuttings from rotary drilling operations. For this reason, the USGS interpretation of lithology (Anderson et al.1996) at the SDA is based on correlating NGR response with seven core logs exclusively.

The quality of available lithology logs varies greatly. Care and judgment are necessary when selecting and using lithology logs for stratigraphic analyses and comparison to geophysical logs, especially for recognizing and avoiding simplified logs whenever possible.

3.3.2 Precision and Accuracy of Depth Selections Based on Lithology Logs

Several factors contribute to a general lack of both accuracy and precision for unit depths reported on lithology logs. The first of these factors is the uncertainty of points for measuring the depth to contacts in boreholes. The measuring point used for a lithology log, whether it is a Kelly bushing, a benchmark, or the land surface, can make a difference of several feet. Simplifying a lithology log from more complete information also affects the accuracy and precision of depth estimates since the process of simplification decreases the vertical resolution and edits out finer details.

A more important factor is that depths determined by chip and mud logging are neither precise nor accurate. The vertical resolution of chip logging on a cable tool rig is never finer than the interval at which the chips are bailed from the borehole. In the 1950s and 1960s at the INEEL, chips were usually bailed every 5 ft, which is why many older lithology logs report lithology at 5-ft intervals. In contrast, any depth estimates while logging on a mud rotary or air rotary rig must account for the rate of drill bit advance and the rate of mud, water, or air circulation. Making a depth estimate for a rock fragment brought up by a rotary rig is not an exact science, though knowing the amount of drill steel in the ground significantly improves the accuracy of such estimates. A depth estimate on any rig is also influenced by the person who makes that estimate, thus involving subjective judgments. It is reasonable to assume that lithology log depth estimates are only accurate to ± 5 ft, especially for boreholes drilled with cable tools. As a result, lithology log depths are neither precise nor accurate.

Since lithology logs can be both inaccurate and imprecise for reasons discussed above, it is standard practice in borehole geophysics to correct lithological depth selections using the NGR logs. The process of adjusting the lithology log depths to match the NGR depths will shift the imprecise nature of the lithology log into the more precise reference frame of the NGR log. Comparison of a lithology log and an NGR log should not proceed until both logs share the same frame of reference. Therefore, it is not necessary to examine lithology logs of wells not included in the USGS analysis (Anderson et al. 1996) to form a better stratigraphic framework of interbed stratigraphy at RWMC. A better interpretation of stratigraphy will not necessarily result because of the following: (1) variable quality of lithology logs at the INEEL through time, (2) depth inaccuracies of lithology logs that must always be corrected with geophysical logs, (3) high quality of the stratigraphic paradigm for RWMC formulated by the USGS report, and (4) consistent quality and replicability of geophysical logs at the INEEL over the last 50 years. The lithology logs can be used, however, for those cases in which the NGR logs either were not collected for a drill hole location or the logs were run only for portions of the drill hole. The latter occurs frequently, perhaps because the logging crew was reluctant to log the lower portion of a hole if it were possible for the logging tool to become caught in the borehole.

3.4 Lithology Selection Implementation

Using the conclusions from the evaluation of the three primary data sources, it was decided to:

- Review the USGS selections (Anderson et al. 1996) to ensure that their selections were correctly implemented
- Make new selections for all wells not included in the USGS selections using NGR and other geophysical logs
- Use lithology logs as a last resort in the absence of NGR and other geophysical logs.

For the first part of implementation, the stratigraphic selections made by the USGS (Anderson et al. 1996) were checked to ensure that they were correctly represented in Table 5-9 of the ABRA. The wells in Table 5-9 that reflected the USGS report as the data source were identified. For these wells, no additional lithology evaluations were made, but the values in Table 5-9 were confirmed to be the same as those in the USGS report. There were no corrections necessary to any of the corresponding entries in Table 5-9.

The second part included obtaining natural gamma-ray (NGR) and other geophysical logs for each of the wells listed in Table 5-9 of the ABRA that were not included in the USGS report (Anderson et al. 1996) and for wells drilled since publication of the ABRA. Other geophysical logs that were useful included caliper logs, density logs, and epithermal neutron logs. Where possible, these data sets were used together to correlate and confirm the lithologic selections from the NGR log. Lithologic selections for each well made from the geophysical logs are in Appendixes A, B, and C in several formats.

The third and last part of implementation includes wells or portions of wells for which no borehole geophysical logs had been collected. For these cases, the selections in Table 5-9 of the ABRA were maintained and assumed to be based on lithology logs (e.g., well 93-01 or O-7). Updated well completion figures for wells made after the ABRA was published were used to locate the approximate depths of interbeds where no NGR data was available (e.g., well IE-4). This occurred in several cases for which the NGR logs were not run to the very bottom of a borehole that partially penetrated an interbed. The well completion diagrams for the fifty wells in the vicinity of the SDA for which new lithologic selections are made in this report are included in Appendix D.

4. RESULTS

As shown in Appendix A, Table A-1, a variety of modifications to the stratigraphic selections in Table 5-9 of the ABRA result from this analysis. Most locations show no change, some locations show small changes up to several feet, and several locations show larger changes. Perhaps most important are those locations where stratigraphic thickness changes either to or from zero thickness. These locations have the largest potential to affect confidence in flow and transport simulations by introducing or removing gaps in the interbeds, and are shaded in Table A-1.

Tables 1 and 2 list those locations by well where changes to or from zero thickness occurred. Table 1 shows the locations that previously had zero thickness in the ABRA and are now assigned nonzero thickness. Similarly, Table 2 shows the locations that previously were assigned nonzero thickness and are now assigned a zero thickness.

Of the changes that involved gaps (i.e., zero thickness locations), not all the entries in Tables 1 and 2 were for locations that were inside or within 100 ft of the SDA boundary. For locations inside the SDA or within 100 ft of the SDA, the updated selections result in one new gap in the B-C interbed (7V) and no new gaps in either the A-B or C-D interbeds. Three instances of A-B interbed locations (M17S, IE-7, and DE-7) that were previously identified as gaps being reclassified to nonzero thickness are based on the updated selections. Likewise, one B-C interbed location (IE-6) now has a nonzero thickness based on the updated selections.

Table 1. Well locations previously assigned zero thickness in the *Ancillary Basis for Risk Analysis* and are now assigned nonzero thickness.

Location	Interbed	ABRA Thickness (ft)	Verified Thickness (ft)
M17S	A-B	0	14
IE-7	A-B	0 [a]	7
DE-7	A-B	0 [a]	6
IE-6	B-C	0 [a]	4
M13S	C-D	0	12

ABRA = *Ancillary Basis for Risk Analysis*
a. These thicknesses come from lithology logs, rather than the ABRA.

Table 2. Well locations previously assigned nonzero thickness in the *Ancillary Basis for Risk Analysis* and are now assigned a zero thickness.

Location	Interbed	ABRA Thickness (ft)	Verified Thickness (ft)
M10SR	A-B	4[a]	0
7V	B-C	10	0
M12S	B-C	2	0

ABRA = *Ancillary Basis for Risk Analysis*
a. This thickness came from a lithology log, rather than the ABRA.

Table 3 summarizes the changes in stratigraphic selections at RWMC as a result of this report. The changes to interbed elevations were generally less numerous and less substantive than the interbed thickness changes, and will probably not have a significant impact on the model. The A-B interbed thickness values were revised for 24 out of 47 measurements, or about 50% of the time. The changes are not anticipated to be significant because although the number of positive changes was slightly larger than negative changes for changes equal to or greater than 4 ft, only positive changes were made for changes greater than 10 ft.

The B-C interbed thickness values had 31 out of 47 values revised, and 21 of those changes, or 45% of all measurements, were negative changes (i.e., decreased thickness). Nine of these negative changes for the B-C interbed thickness equated to a change greater than or equal to 4 ft compared to five positive changes greater than or equal to 4 ft. Even with the dominant negative changes, the largest absolute changes in measurement were positive changes that increased the thickness of the interbed.

The C-D interbed had 16 out of 37, or 43%, interbed thickness values changed. Like the B-C interbed, most of the changes were negative changes in the C-D interbed thickness. Five out of the 16 negative changes were greater than or equal to 4 ft compared to two postive changes greater than or equal to 4 ft. The largest absolute changes in measurement were positive changes that increased the thickness of the interbed. The large decrease in elevation of the C-D interbed is due to reinterpretation for wells M12S and M13S. It is anticipated that the net result from all these changes will not substantially affect WAG 7 transport modeling.

Table 3. Summary of changes for wells evaluated in this report.

Comparison Category	Alluvium Thickness	A-B Interbed Elevation Top	A-B Interbed Thickness	B-C Interbed Elevation Top	B-C Interbed Thickness	C-D Interbed Elevation Top	C-D Interbed Thickness
Number changed positive	5	9	10	9	11	7	5
Number changed negative	7	8	14	15	21	10	11
Number unchanged	35	30	23	23	15	20	21
Maximum positive change	+4	+12	+14	+18	+6	+14	+18
Maximum negative change	-16	-2	-5	-5	-10	-63	-9
Number of positive changes >= 4 ft	1	3	7	4	5	4	2
Number of negative changes >= 4 ft	4	0	3	3	9	5	5
Number of positive changes >= 10 ft	0	2	3	2	0	1	2
Number of negative changes >= 10 ft	4	0	0	0	1	3	0

Note 1: Combined number of positive, negative, and unchanged entries decreases for the C-D interbed because not all wells reevaluated reach that depth.

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Appendix A

Previous Lithologic Selections and Updated Lithologic Selections for Wells in the Vicinity of the Subsurface Disposal Area

Appendix A

Previous Lithologic Selections and Updated Lithologic Selections for Wells in the Vicinity of the Subsurface Disposal Area

Table A-1 shows the data sources and changes to the ABRA Table 5-9 depth and thickness selections for the surficial sediments and to the A-B, B-C, and C-D interbeds. The table also presents updated stratigraphy selections for all wells drilled in the SDA vicinity through 2003 that were not included in the ABRA. The color shading in the table represents the following:

- Green highlighted text indicates stratigraphy selections based on the USGS report (Anderson et al. 1996). These values were left unchanged.

- Blue highlighted text indicates stratigraphy selections resulting from interpretations made as part of this document based on geophysical logs.

- Black text indicates wells for which the stratigraphy selections for the entire well were based solely on lithology logs, rather than geophysical logs.

- Shaded cells indicate those locations that changed from a nonzero interbed thickness to a zero interbed thickness or from a zero interbed thickness to a nonzero interbed thickness.

The last column of Table A-1 indicates the primary data source. The data sources are either stratigraphy selections based on interpretations made by the USGS (Anderson et al.1996) from natural gamma-ray (NGR) logs, or supporting geophysical logs interpreted in this analysis which are included in Appendix C, or from lithologic logs from well completion reports included in Appendix D. The latter were used only in the absence of NGR data to make lithologic selections for this report.

Three wells (6E, 7E, and DE-1) are included in Table A-1 for completeness because these wells do exist to depth inside the SDA, even though there is essentially no geophysical or lithologic information for these wells. A group of wells at the end of Table A-1 was drilled after the ABRA was published. For this group of wells, the ABRA columns give the values from the lithologic logs in Casper, Patchen, and Oberhansley (2003) to allow a comparison of stratigraphic selections from lithologic logs against selections made from NGR logs

Table A-1. Verified and validated stratigraphic data used for the Radioactive Waste Management Complex.

Common Well Name	Alias	Ground Elevation (ft msl)	ABRA Alluvium Thickness (ft)	Verified Alluvium Thickness (ft)	ABRA A-B Interbed Elevation Top (ft msl)	Verified A-B Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA B-C Interbed Elevation Top (ft msl)	Verified B-C Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA C-D Interbed Elevation Top (ft msl)	Verified C-D Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	Verified Data Source
76-1	76-1	5,009	7	*	4,983	*	9	*	4,921	*	0	*	4,790	*	>9	*	Anderson, 1996
76-2	76-2	5,010	12	*	4,989	*	4	*	4,924	*	0	*	4,789	*	>32	*	Anderson, 1996
76-3	76-3	5,010	18	*	4,988	*	3	*	4,917	*	26	*	4,790	*	>20	*	Anderson, 1996
76-4	76-4	5,011	7	*	4,995	*	7	*	4,915	*	4	*	-	*	-	*	Anderson, 1996
76-4a	76-4a	5,011	2	*	4,995	*	8	*	4,915	*	3	*	4,790	*	>33	*	Anderson, 1996
76-5	76-5	5,011	11	*	5,000	*	0	*	4,918	*	17	*	4,791	*	20	*	Anderson, 1996
76-6	76-6	5,011	4	*	5,007	*	0	*	4,913	*	4	*	4,783	*	6	*	Anderson, 1996
77-1	77-1	5,017	4	*	4,977	*	8	*	4,919	*	6	*	4,789	*	22	*	Anderson, 1996
77-2	77-2	5,014	18	*	4,986	*	3	*	-	*	-	*	-	*	-	*	Anderson, 1996
78-1	78-1	5,010	15	*	4,995	*	0	*	-	*	-	*	-	*	-	*	Anderson, 1996
78-2	78-2	5,007	2	*	4,989	*	5	*	4,914	*	7	*	4,784	*	>30	*	Anderson, 1996
78-3	78-3	5,011	4	*	4,999	*	0	*	4,919	*	0	*	4,786	*	>23	*	Anderson, 1996
78-4	78-4	5,018	2	*	4,976	*	5	*	4,920	*	7	*	4,790	*	20	*	Anderson, 1996
78-5	78-5	5,010	12	*	4,998	*	0	*	4,915	*	28	*	4,790	*	>30	*	Anderson, 1996
79-1	79-1	5,010	5	*	5,005	*	0	*	4,897	*	28	*	4,785	*	5	*	Anderson, 1996
79-2	79-2	5,011	13	*	4,987	*	3	*	4,913	*	4	*	-	*	-	*	Anderson, 1996
79-3	79-3	5,008	13	*	4,995	*	0	*	4,909	*	4	*	4,780	*	29	*	Anderson, 1996
88-02D	88-02D	5,006	6	*	4,981	*	3	*	4,912	*	8	*	-	*	-	*	Anderson, 1996
88-01D	88-01D	5,008	18	*	4,990	*	0	*	4,907	*	4	*	4,781	*	>5	*	Anderson, 1996
89-01D	89-01D	5,009	22	*	4,987	*	0	*	4,908	*	7	*	4,781	*	>14	*	Anderson, 1996
89-02D	89-02D	5,011	16	*	4,995	*	0	*	4,910	*	9	*	4,780	*	7	*	Anderson, 1996
9301[1]	93-01	5,009	20	21	4,989	-	0	=	4,903	4,904	4	3	4,781	llp	>10	llp	This report
9302[1]	93-02	5,009	29	33	4,980	-	0	=	4,902	4,905	6	5	4,779	=	>8	>5	This report
USGS-009	USGS-9	5,032	9	*	5,000	*	0	*	4,878	*	38	*	-	*	0	*	Anderson, 1996
USGS-086	USGS-86	5,081	14	*	-	*	0	*	-	*	0	*	-	*	0	*	Anderson, 1996
USGS-087	USGS-87	5,016	3	*	4,975	*	5	*	4,920	*	0	*	4,787	*	15	*	Anderson, 1996
USGS-088	USGS-88	5,020	5	*	5,015	*	0	*	4,917	*	11	*	4,789	*	33	*	Anderson, 1996
USGS-089	USGS-89	5,029	10	*	4,985	*	0	*	4,932	*	14	*	4,798	*	14	*	Anderson, 1996
USGS-090	USGS-90	5,010	5	*	5,005	*	0	*	4,906	*	22	*	4,763	*	5	*	Anderson, 1996
USGS-091	USGS-91	5,006	9	*	4,997	*	0	*	4,910	*	15	*	4,777	*	19	*	Anderson, 1996
USGS-092	USGS-92	5,008	19	*	4,989	*	0	*	4,922	*	5	*	4,790	*	28	*	Anderson, 1996

Table A-1. (continued).

Common Well Name	Alias	Ground Elevation (ft msl)	ABRA Alluvium Thickness (ft)	Verified Alluvium Thickness (ft)	ABRA A-B Interbed Elevation Top (ft msl)	Verified A-B Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA B-C Interbed Elevation Top (ft msl)	Verified B-C Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA C-D Interbed Elevation Top (ft msl)	Verified C-D Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	Verified Data Source
USGS-093	USGS-93	5,010	13	*	4,997	*	0	*	4,914	*	12	*	4,792	*	11	*	Anderson, 1996
USGS-093A	USGS-93A	5,010	11	*	4,999	*	0	*	4,916	*	13	*	4,793	*	9	*	Anderson, 1996
USGS-094	USGS-94	5,008	12	*	4,996	*	0	*	4,915	*	18	*	4,788	*	26	*	Anderson, 1996
USGS-095	USGS-95	5,008	23	*	4,985	*	0	*	4,912	*	16	*	4,786	*	12	*	Anderson, 1996
USGS-096	USGS-96	5,009	13	*	4,978	*	4	*	4,912	*	27	*	4,790	*	10	*	Anderson, 1996
USGS-096B	USGS-96B	5,009	14	*	4,977	*	5	*	4,911	*	28	*	4,791	*	>11	*	Anderson, 1996
USGS-105	USGS-105	5,090	15	*	5,075	*	0	*	-	*	0	*	-	*	0	*	Anderson, 1996
USGS-106	USGS-106	5,017	3	*	5,014	*	0	*	4,886	*	22	*	-	*	0	*	Anderson, 1996
USGS-108	USGS-108	5,033	7	*	5,026	*	0	*	4,844	*	82	*	4,715	*	0	*	Anderson, 1996
USGS-109	USGS-109	5,045	1	*	5,044	*	0	*	4,873	*	12	*	-	*	0	*	Anderson, 1996
USGS-117	USGS-117	5,012	14	*	4,998	*	0	*	4,915	*	5	*	4,789	*	28	*	Anderson, 1996
USGS-118	USGS-118	5,013	14	*	4,999	*	0	*	4,910	*	11	*	4,791	*	28	*	Anderson, 1996
USGS-119	USGS-119	5,031	3	*	5,028	*	0	*	4,919	*	5	*	4,783	*	19	*	Anderson, 1996
USGS-120	USGS-120	5,042	12	*	5,030	*	0	*	4,911	*	40	*	4,790	*	14	*	Anderson, 1996
D-O2	DO-2	5,012	15	*	4,984	*	3	*	4,914	*	5	*	4,789	*	>12	*	Anderson, 1996
D-O6	DO-6	5,012	3	*	4,973	*	9	*	4,925	*	0	*	-	*	-	*	Anderson, 1996
D-O6A	DO-6A	5,012	2	*	4,971	*	>9	*	-	*	-	*	-	*	-	*	Anderson, 1996
D-10	D-10	5,009	9	*	4,981	*	9	*	4,916	*	2	*	4,791	*	11	*	Anderson, 1996
D-15	D-15	5,011	2	*	4,980	*	4	*	4,917	*	18	*	4,793	*	20	*	Anderson, 1996
RWMC	RWMC	5,005	7	*	4,998	*	0	*	4,909	*	6	*	4,786	*	17	*	Anderson, 1996
TW-1	TW-1	5,010	14	*	4,977	*	0	*	4,913	*	5	*	4,789	*	>17	*	Anderson, 1996
RWMC-PRO-A-084	Test Well	5,042	3	=	5,039	=	0	=	4,912	=	10	=	4,788	=	20	=	Lithology log
WWW1	WWW#1	5,036	5	*	4,992	*	11	*	4,931	*	16	*	4,805	*	21	*	Anderson, 1996
WWW2	WWW#2	5,036	3	*	5,001	*	10	*	4,933	*	>18	*	-	*	-	*	Anderson, 1996
VZT-01	VZT-1	5,018	4	*	4,975	*	7	*	4,918	*	18	*	-	*	-	*	Anderson, 1996
C-1	C-1	5,029	2	*	4,993	*	2	*	4,909	*	5	*	4,799	*	10	*	Anderson, 1996
C1A	C-1A	5,029	4	*	4,993	*	0	*	4,911	*	4	*	4,799	*	12	*	Anderson, 1996
RIFLE RANGE	RIFLE RANGE	4,967	9	*	4,958	*	20	*	4,849	*	0	*	4,821	*	0	*	Anderson, 1996
HWY-3	HWY-3	4,981	21	*	4,960	*	14	*	4,835	*	0	*	4,816	*	0	*	Anderson, 1996
EBR-I	EBR-I	5,024	11	*	5,013	*	0	*	4,900	*	24	*	4,788	*	5	*	Anderson, 1996
RWMC-MON-A-013	A11A31	5,065	3	*	5,062	*	0	*	4,892	*	66	*	4,782	*	35	*	Anderson, 1996
RWMC-MON-A-065	OW-1	5,042	5	*	5,037	*	0	*	4,915	*	30	*	4,787	*	14	*	Anderson, 1996

Table A-1. (continued).

Common Well Name	Alias	Ground Elevation (ft msl)	ABRA Alluvium Thickness (ft)	Verified Alluvium Thickness (ft)	ABRA A-B Interbed Elevation Top (ft msl)	Verified A-B Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA B-C Interbed Elevation Top (ft msl)	Verified B-C Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA C-D Interbed Elevation Top (ft msl)	Verified C-D Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	Verified Data Source
RWMC-MON-A-066	OW-2	5,044	7	*	5,037	*	0	*	4,910	*	42	*	4,784	*	4	*	Anderson, 1996
NA89-1	NA89-1	5,045	2	*	4,995	*	0	*	4,931	*	17	*	4,821	*	8	*	Anderson, 1996
NA89-2	NA89-2	5,059	12	*	5,014	*	0	*	4,863	*	4	*	-	*	-	*	Anderson, 1996
NA89-3	NA89-3	5,038	1	*	5,037	*	0	*	4,909	*	46	*	-	*	-	*	Anderson, 1996
M1SA	M1SA	5,011	7	*	4,980	*	5	*	4,917	*	20	*	4,790	*	20	*	Anderson, 1996
M3S	M3S	5,016	5	*	4,989	*	3	*	4,910	*	15	*	4,792	*	3	*	Anderson, 1996
M4D	M4D	5,023	8	*	5,015	*	0	*	4,914	*	29	*	4,787	*	28	*	Anderson, 1996
M6S	M6S	5,066	7	*	5,059	*	0	*	4,900	*	10	*	4,746	*	18	*	Anderson, 1996
M7S	M7S	5,005	9	*	4,996	*	0	*	4,908	*	6	*	4,782	*	0	*	Anderson, 1996
M10S	M10S	5,022	6	*	5,016	*	0	*	4,910	*	24	*	4,789	*	27	*	Anderson, 1996
VVE-1	VVE-1	5,011	8	=	4,980	=	6	=	4,917	=	22	=	4,792	=	>23	=	Lithology log
VVE-3	VVE-3	5,015	6	=	4,987	4,985	4	2	4,909	4,907	14	10	4,792	4,789	>10	4	This report
VVE-4	VVE-4	5,022	8	=	5,000	4,999	15	10	4,916	4,911	31	23	4,787	4,785	>23	>18	This report
VVE-6A	VVE-6A	5,066	4	=	5,062	-	0	=	4,903	4,899	14	5	-	=	-	=	This report
VVE-7	VVE-7	5,004	14	=	4,990	=	0	=	4,887	4,905	11	5	4,784	4,781	>7	=	This report
VVE-10	VVE-10	5,021	6	=	5,015	=	0	=	4,908	4,905	24	22	4,781	4,778	>18	13	This report
RWMC-VVE-V-067	1E	5,006	15	=	4,991	=	0	=	4,907	4,908	>7	=	-	=	-	=	This report
RWMC-GAS-V-072	1V	5,006	9	=	4,997	=	0	=	4,911	=	7	=	-	=	-	=	This report
RWMC-VVE-V-068	2E	5,008	15	16	4,979	4,980	3	2	4,912	=	>3	1	-	=	-	=	This report
RWMC-GAS-V-073	2V	5,006	7	=	4,999	=	0	=	4,910	=	9	=	4,767	=	>3	=	This report
RWMC-VVE-V-069	3E	5,012	5	=	5,007	=	0	=	4,913	4,912	3	2	-	=	-	=	This report
RWMC-GAS-V-074	3V	5,009	17	16	4,982	=	4	3	4,910	=	4	=	4,787	=	>2	1	This report
RWMV-VVE-V-070	4E	5,014	23	22	4,991	=	0	=	4,913	=	>4	3	-	=	-	=	This report
RWMC-GAS-V-075	4V	5,012	10	=	5,002	=	0	=	4,908	=	13	=	4,781	=	>4	=	Lithology log
RWMC-VVE-V-071	5E	5,013	21	=	4,992	=	0	=	4,916	=	>4	2	-	=	-	=	This report
RWMC-GAS-V-076	5V	5,011	9	=	4,992	=	7	6	4,913	=	3	=	-	=	-	=	This report
RWMC-GAS-V-077	6V	5,017	10	9	4,986	4,985	7	5	4,926	4,924	4	1	4,793	=	>2	1	This report
RWMC-GAS-V-078	7V	5,009	15	16	4,987	=	7	6	4,925	=	10	0	4,786	=	>5	4	This report
RWMC-GAS-V-079	8V	5,012	21	=	4,991	=	0	=	4,914	4,913	37	=	4,786	=	>1	=	This report
RWMC-GAS-V-080	9V	5,014	20	21	4,994	-	0	=	4,913	4,911	20	=	4,786	=	>1	=	This report
RWMC-GAS-V-081	10V	5,013	10	=	4,993	4,992	9	7	4,916	=	14	15	4,789	=	>5	=	This report
SOUTH-MON-A-001	M11S	4,994	10	=	4,984	=	0	=	4,903	=	5	=	4,787	4,786	23	21	This report

Table A-1. (continued).

Common Well Name	Alias	Ground Elevation (ft msl)	ABRA Alluvium Thickness (ft)	Verified Alluvium Thickness (ft)	ABRA A-B Interbed Elevation Top (ft msl)	Verified A-B Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA B-C Interbed Elevation Top (ft msl)	Verified B-C Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA C-D Interbed Elevation Top (ft msl)	Verified C-D Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	Verified Data Source
SOUTH-MON-A-002	M12S[2]	4,975	8	=	4,967	=	0	=	4,911	=	2	0	4,783	4,720	12	30	This report
SOUTH-MON-A-003	M13S[2]	5,027	16	=	5,011	=	0	=	4,894	4,895	12	=	4,781	4,719	0	12	This report
SOUTH-MON-A-004	M14S	5,032	7	=	5,025	=	0	=	4,904	=	0	=	4,824	=	0	=	Lithology log
SOUTH-MON-A-009	M15S	5,019	18	=	5,001	=	0	=	4,889	4,896	27	32	4,789	4,779	15	6	This report
SOUTH-MON-A-010	M16S	5,004	18	5	4,986	-	0	=	4,886	4,902	10	9	4,807	=	12	=	This report
RWMC-MON-A-162	M17S	5,012	23	=	4,989	=	0	14	4,911	=	10	6	4,784	=	22	23	This report
SOUTH-GAS-V-005	VVE-11[4]	4,994	2	=	-	=	-	=	4,899	=	3	=	-	=	-	=	Lithology log
SOUTH-GAS-V-007	VVE–13[4]	5,027	2	=	-	=	-	=	4,894	=	20	=	4,774	=	10	=	Lithology log
SOUTH-GAS-V-008	VVE–14[4]	5,034	2	=	-	=	-	=	-	=	-	=	4,974	=	2	=	Lithology log
RWMC-SCI-V-153	I-1S	5,013	8	=	5,005	=	0	=	4,913	=	11	=	-	=	-	=	Lithology log
RWMC-SCI-V-154	I-1D	-	-	=	-	=	-	=	-	=	-	=	4,790	=	20	=	Lithology log
RWMC-SCI-V-155	I-2S	5,014	18	=	4,996	=	0	=	4,911	=	11	=	-	=	-	=	Lithology log
RWMC-SCI-V-156	I-2D	-	-	=	-	=	-	=	-	=	-	=	4,791	=	1	=	Lithology log
RWMC-SCI-V-157	I-3S	5,012	16	=	4,985	=	2	=	4,914	=	4	=	-	=	-	=	Lithology log
RWMC-SCI-V-158	I-3D	-	-	=	-	=	-	=	-	=	-	=	4,787	=	>11	=	Lithology log
RWMC-SCI-V-159	I-4S	5,009	15	=	4,994	=	0	=	4,912	=	2	=	-	=	-	=	Lithology log
RWMC-SCI-V-160	I-4D	-	-	=	-	=	-	=	-	=	-	=	4,787	=	>16	=	Lithology log
RWMC-SCI-V-161	I-5S	5,012	32	=	4,980	=	0	=	4,913	=	>6	=	-	=	-	=	Lithology log
SOUTH-SCI-V-011	O-1	5,011	8	=	4,979	=	1	=	4,917	=	18	=	4,790	=	>15	=	Lithology log
SOUTH-SCI-V-012	O-2	5,014	5	=	5,009	=	0	=	4,907	=	18	17	4,771	4,776	>7	llp	This report
SOUTH-SCI-V-013	O-3	5,010	8	=	4,975	=	9	4	4,919	4,918	12	7	4,789	=	>15	llp	This report
SOUTH-SCI-V-018	O-4	5,014	11	=	4,970	4,982	7	6	4,909	=	18	=	4,789	=	>19	=	This report
SOUTH-SCI-V-015	O-5	5,021	2	=	4,976	4,979	6	4	4,916	4,915	23	>14	4,789	llp	26	llp	This report
SOUTH-SCI-V-014	O-6	5,013	10	=	4,982	4,987	6	2	4,905	4,913	14	19	4,789	4,783	>26	=	This report
SOUTH-SCI-V-016	O-7	5,033	4	=	5,006	=	6	=	4,915	4,911	34	30	4,788	llp	>4	llp	This report
SOUTH-SCI-V-203	O-8	5,010	8	=	5,002	=	0	=	4,910	=	0	=	4,777	=	>1	=	Lithology log
SOUTH-1835	M10SR, S1835[1]	5,021	9	<10	4,986	-	4	0	4,909	4,907	20	22	4,785	4,780	14	15	This report
SOUTH-1898	S1898[1]	5,009	16	16	-	-	0	0	-	-	-	0	4,775	4,782	6	26	This report
RWMC-VVE-V-205	6E[1]	5,011					No geophysical logs found and no lithology indicated on well completion diagram										
RWMC-VVE-V-204	7E[1]	5,010					No geophysical logs found and no lithology indicated on well completion diagram										
RWMC-VVE-V-163	DE-1[1]	5,012					No geophysical logs found and no lithology indicated on well completion diagram										
RWMC-1808	SE-3[1,3]	5,010	6	=	4,974	4,976	3	4	4,911	=	>1	=	-	=	-	=	This report

Table A-1. (continued).

Common Well Name	Alias	Ground Elevation (ft msl)	ABRA Alluvium Thickness (ft)	Verified Alluvium Thickness (ft)	ABRA A-B Interbed Elevation Top (ft msl)	Verified A-B Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA B-C Interbed Elevation Top (ft msl)	Verified B-C Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	ABRA C-D Interbed Elevation Top (ft msl)	Verified C-D Interbed Elevation Top (ft msl)	ABRA Interbed Thickness (ft)	Verified Interbed Thickness (ft)	Verified Data Source
RWMC-1809	IE-3[1,3]	5,010	8	=	4,974	4,976	7	6	4,912	4,911	10	16	4,787	4,789	>3	=	This report
RWMC-1810	DE-3[1,3]	5,010	8	=	4,974	=	6	4	4,910	=	7	8	4,787	4,788	20	=	This report
RWMC-1812	IE-4[1,3]	5,010	17	=	4,976	4,975	3	4	-	=	0	=	4,786	llp	>1	llp	This report
RWMC-1813	DE-4[1,3]	5,010	17	=	4,979	4,978	2	15	4,915	4,914	2	6	4,786	=	21	18	This report
RWMC-1814	SE-6[1,3]	5,014	16	=	4,980	=	2	=	4,913	=	>1	=	-	=	-	=	Lithology log
RWMC-1815	IE-6[1,3]	5,014	21	=	4,979	4,980	1	5	-	4,914	0	4	4,786	4,800	>1	=	This report
RWMC-1816	DE-6[1,3]	5,014	17	=	4,979	4,981	2	7	4,913	=	1	4	4,785	4,789	25	28	This report
RWMC-1817	SE-7[1,3]	5,014	26	10	4,984	4,994	1	11	4,910	llp	>1	llp	-	=	-	=	This report
RWMC-1818	IE-7[1,3]	5,015	21	10	-	4,999	0	7	4,911	=	2	5	4,785	4,788	>2	llp	This report
RWMC-1819	DE-7[1,3]	5,015	24	<12	-	4,995	0	6	4,911	4,910	2	4	4,784	=	25	26	This report
RWMC-1820	SE-8[1,3]	5,008	11	=	4,980	=	3	=	4,913	=	8	=	-	=	-	=	Lithology log
RWMC-1821	IE-8[1,3]	5,008	10	=	4,981	4,980	5	=	4,910	4,912	7	9	4,784	4,788	>1	llp	This report
RWMC-1822	DE-8[1,3]	5,008	11	=	4,981	4,980	3	4	4,912	4,911	8	7	4,786	4,781	27	22	This report

ABRA = *Ancillary Basis for Risk Analysis*
msl = mean sea level
= indicates no change in data from the ABRA data, or agreement with lithology logs
- indicates that either the well was not drilled deep enough or lithologic information could not be extracted from the data
llp lithology log selection is all that is available, no natural gamma-ray data to select from
* Anderson et al. selections not modified
> indicates partial penetration of an interbed
1. well not included in the USGS report (Anderson et al.1996) or drilled after publication of the ABRA
2. Lithologic selections for M12S and M13S depart from Anderson's selections for EBR-I, which are being reassessed by the USGS. Anderson's selections for EBR-I are excluded from Appendix B results
3. values in ABRA columns are from lithology logs, not from ABRA
4. too little confidence in these lithology log values to use further in evaluations, values excluded from Appendix B results.

Appendix B

Updated Subsurface Disposal Area Lithologic Selections for Wells in the Vicinity of the Subsurface Disposal Area

Appendix B

Updated Subsurface Disposal Area Lithologic Selections for Wells in the Vicinity of the Subsurface Disposal Area

Table B-1 shows summarized information from Appendix A, and represents the updated lithologic database that will be used for conducting contaminant transport modeling at the SDA. Table entries shown in parentheses are either values from Table 5-9 in the ABRA, or are values from lithology logs for wells drilled after publication of the ABRA.

The color shading in the table is similar to Table A-1 and represents the following:

- Green highlighted text indicates stratigraphy selections based on the USGS report (Anderson et al. 1996). These values were left unchanged.

- Black text indicates wells for which the stratigraphy selections were based on either selections resulting from interpretations made as part of this document based on geophysical logs or from lithology logs.

Table B-1. Verified and validated stratigraphic data used for the Radioactive Waste Management Complex (previous values in parentheses).

Alias Well Name	Ground Elevation (ft msl)	Alluvium Thickness (ft)	A-B Interbed Elevation Top (ft msl)	A-B Interbed Thickness (ft)	B-C Interbed Elevation Top (ft msl)	B-C Interbed Thickness (ft)	C-D Interbed Elevation Top (ft msl)	C-D Interbed Thickness (ft)
76-1	5,009	7	4,983	9	4,921	0	4,790	>9
76-2	5,010	12	4,989	4	4,924	0	4,789	>32
76-3	5,010	18	4,988	3	4,917	26	4,790	>20
76-4	5,011	7	4,995	7	4,915	4	—	—
76-4a	5,011	2	4,995	8	4,915	3	4,790	>33
76-5	5,011	11	5,000	0	4,918	17	4,791	20
76-6	5,011	4	5,007	0	4,913	4	4,783	6
77-1	5,017	4	4,977	8	4,919	6	4,789	22
77-2	5,014	18	4,986	3	—	—	—	—
78-1	5,010	15	4,995	0	—	—	—	—
78-2	5,007	2	4,989	5	4,914	7	4,784	>30
78-3	5,011	4	4,999	0	4,919	0	4,786	>23
78-4	5,018	2	4,976	5	4,920	7	4,790	20
78-5	5,010	12	4,998	0	4,915	28	4,790	>30
79-1	5,010	5	5,005	0	4,897	28	4,785	5
79-2	5,011	13	4,987	3	4,913	4	—	—
79-3	5,008	13	4,995	0	4,909	4	4,780	29
88-02D	5,006	6	4,981	3	4,912	8	—	—
88-01D	5,008	18	4,990	0	4,907	4	4,781	>5
89-01D	5,009	22	4,987	0	4,908	7	4,781	>14
89-02D	5,011	16	4,995	0	4,910	9	4,780	7
93-01	5,009	21 (20)	- (4,989)	0	4,904 (4,903)	3 (4)	4,781	>10
93-02	5,009	33 (29)	- (4,980)	0	4,905 (4,902)	5 (6)	4,779	>5 (>8)

Table B-1. (continued).

Alias Well Name	Ground Elevation (ft msl)	Alluvium Thickness (ft)	A-B Interbed Elevation Top (ft msl)	A-B Interbed Thickness (ft)	B-C Interbed Elevation Top (ft msl)	B-C Interbed Thickness (ft)	C-D Interbed Elevation Top (ft msl)	C-D Interbed Thickness (ft)
USGS-9	5,032	9	5,000	0	4,878	38	—	0
USGS-86	5,081	14	—	0	—	0	—	0
USGS-87	5,016	3	4,975	5	4,920	0	4,787	15
USGS-88	5,020	5	5,015	0	4,917	11	4,789	33
USGS-89	5,029	10	4,985	0	4,932	14	4,798	14
USGS-90	5,010	5	5,005	0	4,906	22	4,763	5
USGS-91	5,006	9	4,997	0	4,910	15	4,777	19
USGS-92	5,008	19	4,989	0	4,922	5	4,790	28
USGS-93	5,010	13	4,997	0	4,914	12	4,792	11
USGS-93A	5,010	11	4,999	0	4,916	13	4,793	9
USGS-94	5,008	12	4,996	0	4,915	18	4,788	26
USGS-95	5,008	23	4,985	0	4,912	16	4,786	12
USGS-96	5,009	13	4,978	4	4,912	27	4,790	10
USGS-96B	5,009	14	4,977	5	4,911	28	4,791	>11
USGS-105	5,090	15	5,075	0	—	0	—	0
USGS-106	5,017	3	5,014	0	4,886	22	—	0
USGS-108	5,033	7	5,026	0	4,844	82	4,715	0
USGS-109	5,045	1	5,044	0	4,873	12	—	0
USGS-117	5,012	14	4,998	0	4,915	5	4,789	28
USGS-118	5,013	14	4,999	0	4,910	11	4,791	28
USGS-119	5,031	3	5,028	0	4,919	5	4,783	19
USGS-120	5,042	12	5,030	0	4,911	40	4,790	14
DO-2	5,012	15	4,984	3	4,914	5	4,789	>12
DO-6	5,012	3	4,973	9	4,925	0	—	—
DO-6A	5,012	2	4,971	>9	—	—	—	—

Table B-1. (continued).

Alias Well Name	Ground Elevation (ft msl)	Alluvium Thickness (ft)	A-B Interbed Elevation Top (ft msl)	A-B Interbed Thickness (ft)	B-C Interbed Elevation Top (ft msl)	B-C Interbed Thickness (ft)	C-D Interbed Elevation Top (ft msl)	C-D Interbed Thickness (ft)
D-10	5,009	9	4,981	9	4,916	2	4,791	11
D-15	5,011	2	4,980	4	4,917	18	4,793	20
RWMC	5,005	7	4,998	0	4,909	6	4,786	17
TW-1	5,010	14	4,977	0	4,913	5	4,789	>17
Test Well	5,042	3	5,039	0	4,912	10	4,788	20
WWW#1	5,036	5	4,992	11	4,931	16	4,805	21
WWW#2	5,036	3	5,001	10	4,933	>18	—	—
VZT-1	5,018	4	4,975	7	4,918	18	—	—
C-1	5,029	2	4,993	2	4,909	5	4,799	10
C-1A	5,029	4	4,993	0	4,911	4	4,799	12
RIFLE RANGE	4,967	9	4,958	20	4,849	0	4,821	0
HWY-3	4,981	21	4,960	14	4,835	0	4,816	0
A11A31	5,065	3	5,062	0	4,892	66	4,782	35
OW-1	5,042	5	5,037	0	4,915	30	4,787	14
OW-2	5,044	7	5,037	0	4,910	42	4,784	4
NA89-1	5,045	2	4,995	0	4,931	17	4,821	8
NA89-2	5,059	12	5,014	0	4,863	4	—	—
NA89-3	5,038	1	5,037	0	4,909	46	—	—
M1SA	5,011	7	4,980	5	4,917	20	4,790	20
M3S	5,016	5	4,989	3	4,910	15	4,792	3
M4D	5,023	8	5,015	0	4,914	29	4,787	28
M6S	5,066	7	5,059	0	4,900	10	4,746	18
M7S	5,005	9	4,996	0	4,908	6	4,782	0
M10S	5,022	6	5,016	0	4,910	24	4,789	27
VVE-1	5,011	8	4,980	6	4,917	22	4,792	>23

Table B-1. (continued).

Alias Well Name	Ground Elevation (ft msl)	Alluvium Thickness (ft)	A-B Interbed Elevation Top (ft msl)	A-B Interbed Thickness (ft)	B-C Interbed Elevation Top (ft msl)	B-C Interbed Thickness (ft)	C-D Interbed Elevation Top (ft msl)	C-D Interbed Thickness (ft)
VVE-3	5,015	6	4,985 (4,987)	2 (4)	4,907 (4,909)	10 (14)	4,789 (4,792)	4 (>10)
VVE-4	5,022	8	4,999 (5,000)	10 (15)	4,911 (4,916)	23 (31)	4,785 (4,787)	>18 (>23)
VVE-6A	5,066	4	5,062	0	4,899 (4,903)	5 (14)	—	—
VVE-7	5,004	14	4,990	0	4,905 (4,887)	5 (11)	4,781 (4,784)	>7
VVE-10	5,021	6	5,015	0	4,905 (4,908)	22 (24)	4,778 (4,781)	13 (>18)
1E	5,006	15	4,991	0	4,908 (4,907)	>7	—	—
1V	5,006	9	4,997	0	4,911	7	—	—
2E	5,008	16 (15)	4,980 (4,979)	2 (3)	4,912	1 (>3)	—	—
2V	5,006	7	4,999	0	4,910	9	4,767	>3
3E	5,012	5	5,007	0	4,912 (4,913)	2 (3)	—	—
3V	5,009	16 (17)	4,982	3 (4)	4,910	4	4,787	1 (>2)
4E	5,014	22 (23)	4,991	0	4,913	3 (>4)	—	—
4V	5,012	10	5,002	0	4,908	13	4,781	>4
5E	5,013	21	4,992	0	4,916	2 (>4)	—	—
5V	5,011	9	4,992	6 (7)	4,913	3	—	—
6V	5,017	9 (10)	4,985 (4,986)	5 (7)	4,924 (4,926)	1 (4)	4,793	1 (>2)
7V	5,009	16 (15)	4,987	6 (7)	4,925	0 (10)	4,786	4 (>5)
8V	5,012	21	4,991	0	4,913 (4,914)	37	4,786	>1
9V	5,014	21 (20)	- (4,994)	0	4,911 (4,913)	20	4,786	>1
10V	5,013	10	4,992 (4,993)	7 (9)	4,916	15 (14)	4,789	>5
M11S	4,994	10	4,984	0	4,903	5	4,786 (4,787)	21 (23)
M12S	4,975	8	4,967	0	4,911	0 (2)	4,720 (4,783)	30 (12)
M13S	5,027	16	5,011	0	4,895 (4,894)	12	4,719 (4,781)	12 (0)
M14S	5,032	7	5,025	0	4,904	0	4,824	0
M15S	5,019	18	5,001	0	4,896 (4,889)	32 (27)	4,779 (4,789)	6 (15)

Table B-1. (continued).

Alias Well Name	Ground Elevation (ft msl)	Alluvium Thickness (ft)	A-B Interbed Elevation Top (ft msl)	A-B Interbed Thickness (ft)	B-C Interbed Elevation Top (ft msl)	B-C Interbed Thickness (ft)	C-D Interbed Elevation Top (ft msl)	C-D Interbed Thickness (ft)
M16S	5,004	5 (18)	4,986	0	4,902 (4,886)	9 (10)	4,807	12
M17S	5,012	23	4,989	14 (0)	4,911	6 (10)	4,784	23 (22)
I-1S	5,013	8	5,005	0	4,913	11	—	—
I-1D	—	—	—	—	—	—	4,790	20
I-2S	5,014	18	4,996	0	4,911	11	—	—
I-2D	—	—	—	—	—	—	4,791	1
I-3S	5,012	16	4,985	2	4,914	4	—	—
I-3D	—	—	—	—	—	—	4,787	>11
I-4S	5,009	15	4,994	0	4,912	2	—	—
I-4D	—	—	—	—	—	—	4,787	>16
I-5S	5,012	32	4,980	0	4,913	>6	—	—
O-1	5,011	8	4,979	1	4,917	18	4,790	>15
O-2	5,014	5	5,009	0	4,907	17 (18)	4,776 (4,771)	>7
O-3	5,010	8	4,975	4 (9)	4,918 (4,919)	7 (12)	4,789	>15
O-4	5,014	11	4,982 (4,970)	6 (7)	4,909	18	4,789	>19
O-5	5,021	2	4,979 (4,976)	4 (6)	4,915 (4,916)	>14 (23)	4,789	26
O-6	5,013	10	4,987 (4,982)	2 (6)	4,913 (4,905)	19 (14)	4,783 (4,789)	>26
O-7	5,033	4	5,006	6	4,911 (4,915)	30 (34)	4,788	>4
O-8	5,010	8	5,002	0	4,910	0	4,777	>1
S1835[1]	5,021	10	—	0	4,907	22	4,780	15
S1898[1]	5,009	16	—	0	—	0	4,782	26
SE-3[1,2]	5,010	6	4,976 (4,974)	4 (3)	4,911	>1	—	—
IE-3[1,2]	5,010	8	4,976 (4,974)	6 (7)	4,911 (4,912)	16 (10)	4,789 (4,787)	>3
DE-3[1,2]	5,010	8	4,974	4 (6)	4,910	8 (7)	4,788 (4,787)	20
IE-4[1,2]	5,010	17	4,975 (4,976)	4 (3)	—	0	4,786	>1

Table B-1. (continued).

Alias Well Name	Ground Elevation (ft msl)	Alluvium Thickness (ft)	A-B Interbed Elevation Top (ft msl)	A-B Interbed Thickness (ft)	B-C Interbed Elevation Top (ft msl)	B-C Interbed Thickness (ft)	C-D Interbed Elevation Top (ft msl)	C-D Interbed Thickness (ft)
DE-4[1,2]	5,010	17	4,978 (4,979)	15 (2)	4,914 (4,915)	6 (2)	4,786	18 (21)
SE-6[1,2]	5,014	16	4,980	2	4,913	>1	—	—
IE-6[1,2]	5,014	21	4,980 (4,979)	5 (1)	4,914 (-)	4 (0)	4,800 (4,786)	>1
DE-6[1,2]	5,014	17	4,981 (4,979)	7 (2)	4,913	4 (1)	4,789 (4,785)	28 (25)
SE-7[1,2]	5,014	10 (26)	4,994 (4,984)	11 (1)	4,910	>1	—	—
IE-7[1,2]	5,015	10 (21)	4,999 (-)	7 (0)	4,911	5 (2)	4,788 (4,785)	>2
DE-7[1,2]	5,015	<12 (24)	4,995 (-)	6 (0)	4,910 (4,911)	4 (2)	4,784	26 (25)
SE-8[1,2]	5,008	11	4,980	3	4,913	8	—	—
IE-8[1,2]	5,008	10	4,980 (4,981)	5	4,912 (4,910)	9 (7)	4,788 (4,784)	>1
DE-8[1,2]	5,008	11	4,980 (4,981)	4 (3)	4,911 (4,912)	7 (8)	4,781 (4,786)	22 (27)

msl = mean sea level
> = indicates partial penetration of an interbed
1. Well not included in the USGS report (Anderson et al.1996) or drilled after publication of the *Ancillary Basis for Risk Analysis*
2. Values in parentheses are from lithology logs, not from the *Ancillary Basis for Risk Analysis*.

Appendix C

Geophysical Logs for Wells in the Vicinity of the Subsurface Disposal Area

Appendix C

Geophysical Logs for Wells in the Vicinity of the Subsurface Disposal Area

Appendix C shows graphically the depth and thickness selections for the A-B, B-C, and C-D interbeds for wells in the vicinity of the Subsurface Disposal Area that were evaluated in this analysis. The data used to select the interbeds were obtained from INEEL and USGS logs dating from 1963 to 2003. Logs were recorded by different borehole geophysical tools. Natural gamma, neutron, caliper and density data were evaluated for selection of interbed depth and thickness.

Primarily natural gamma and caliper data are presented with the top and bottom selections for the A-B, B-C, and C-D interbeds. In some instances, only the top of the interbed is selected because of an absence in data (e.g., well not drilled deep enough). Smoothed natural gamma data, as well as natural gamma 21-point and/or 41-point average data, are included for a select number of wells. The date that the specific variable was recorded via log is included in the graph legend.

Morrison Knudsen Corporation logs were used in the depth and thickness selections for RWMC-GAS-V-081 (10V).

CONTENTS

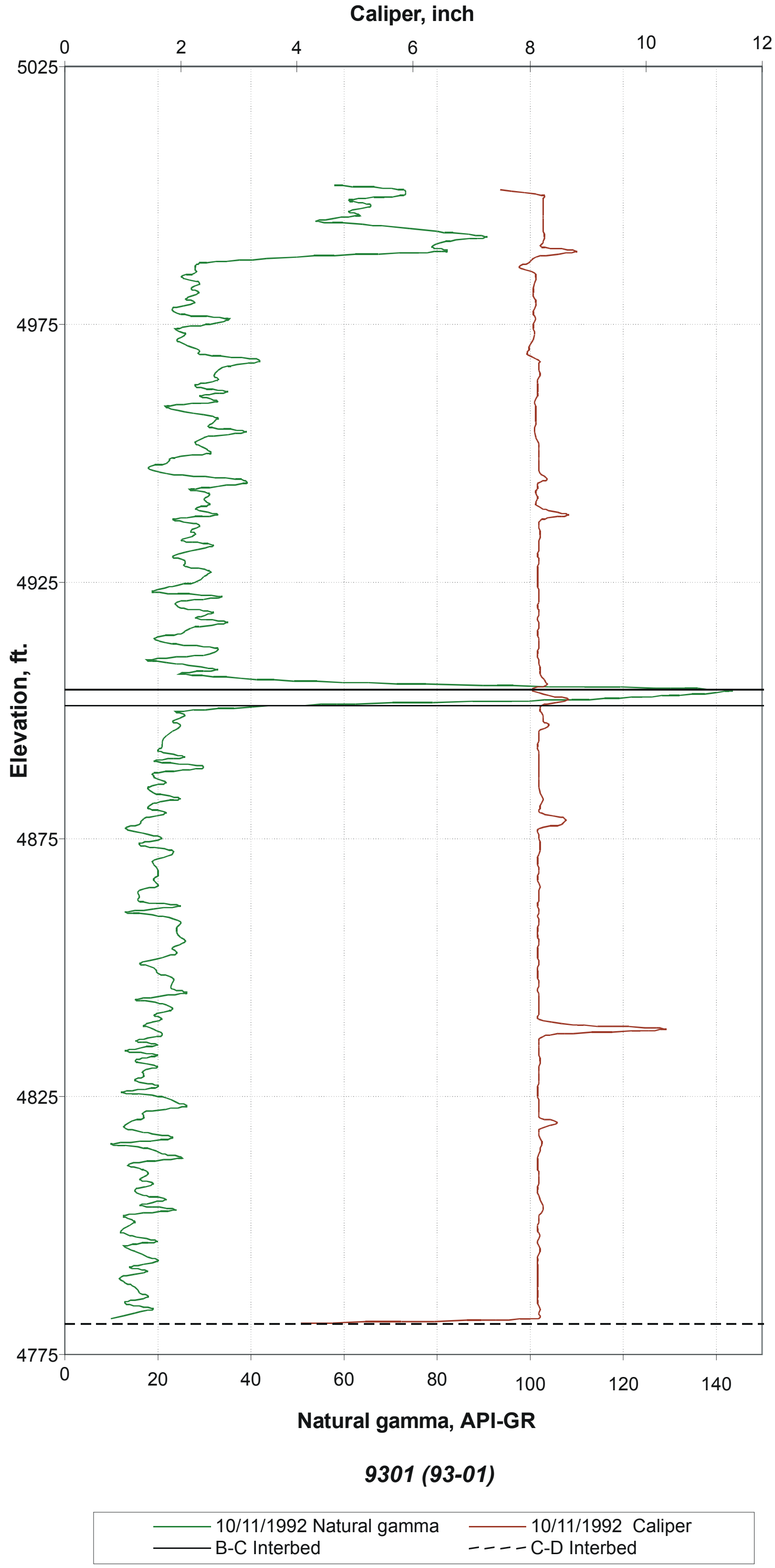


Figure C-1. Well 93-01.

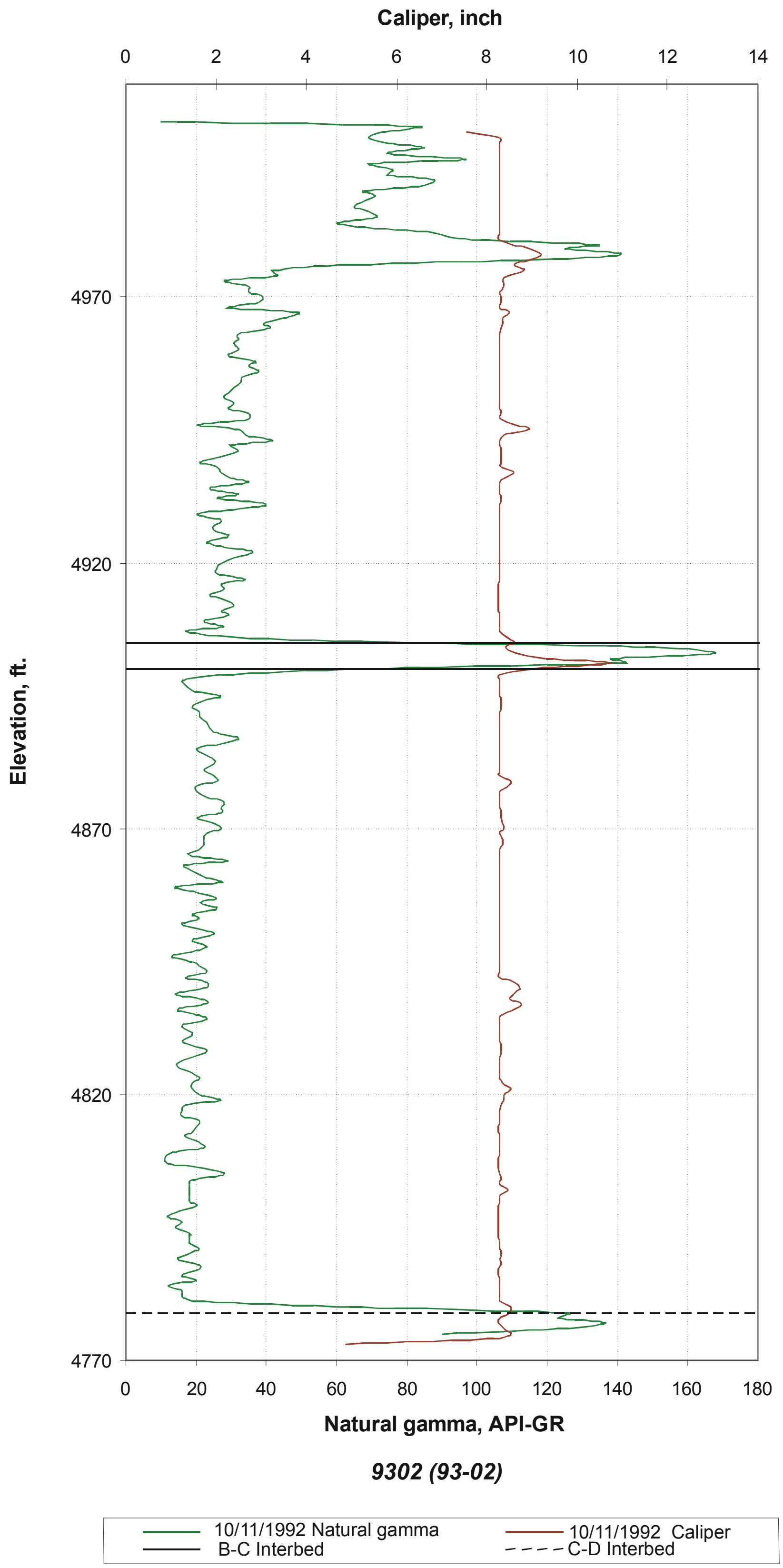


Figure C-2. Well 93-02.

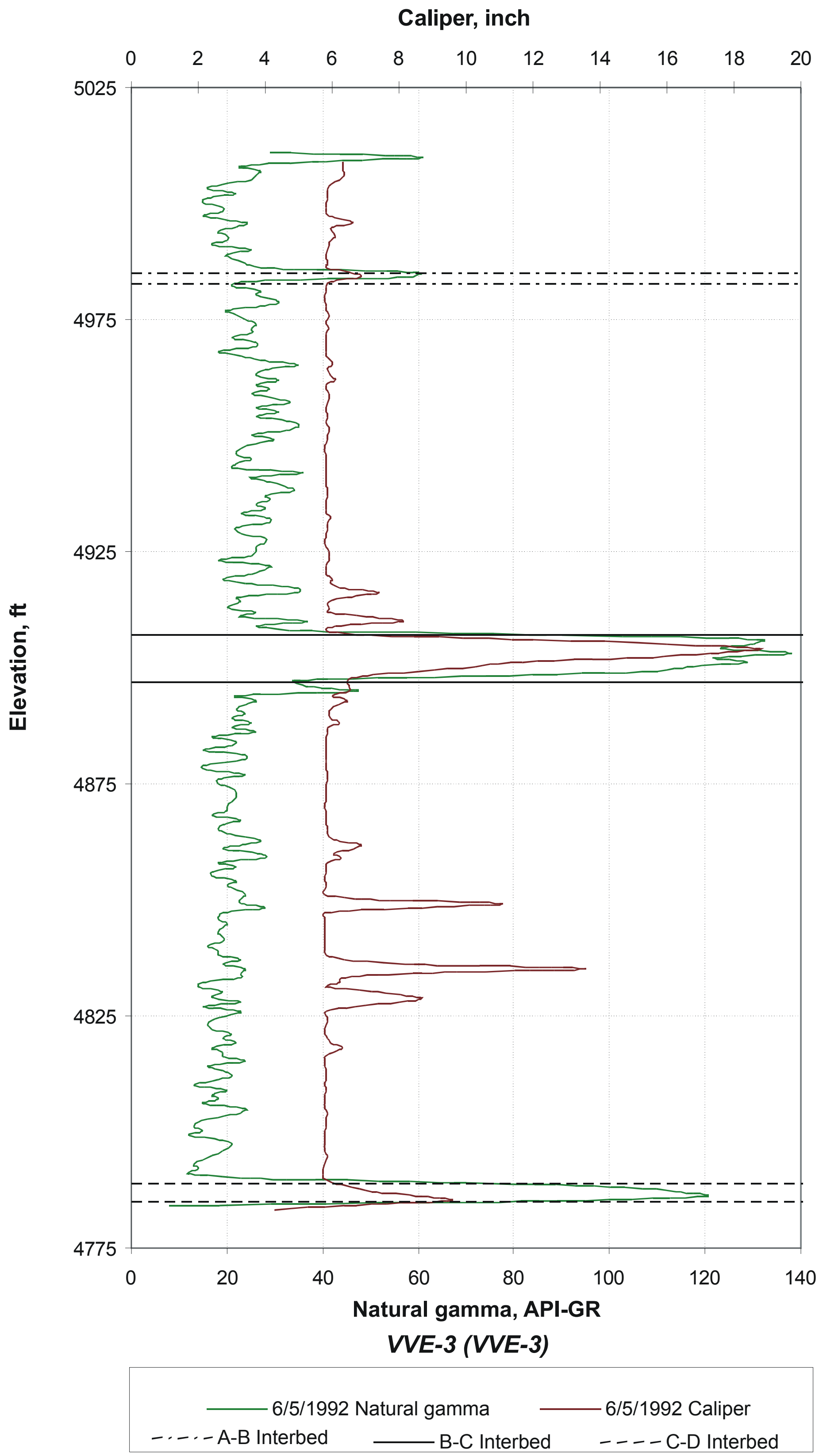


Figure C-3. Well VVE-3.

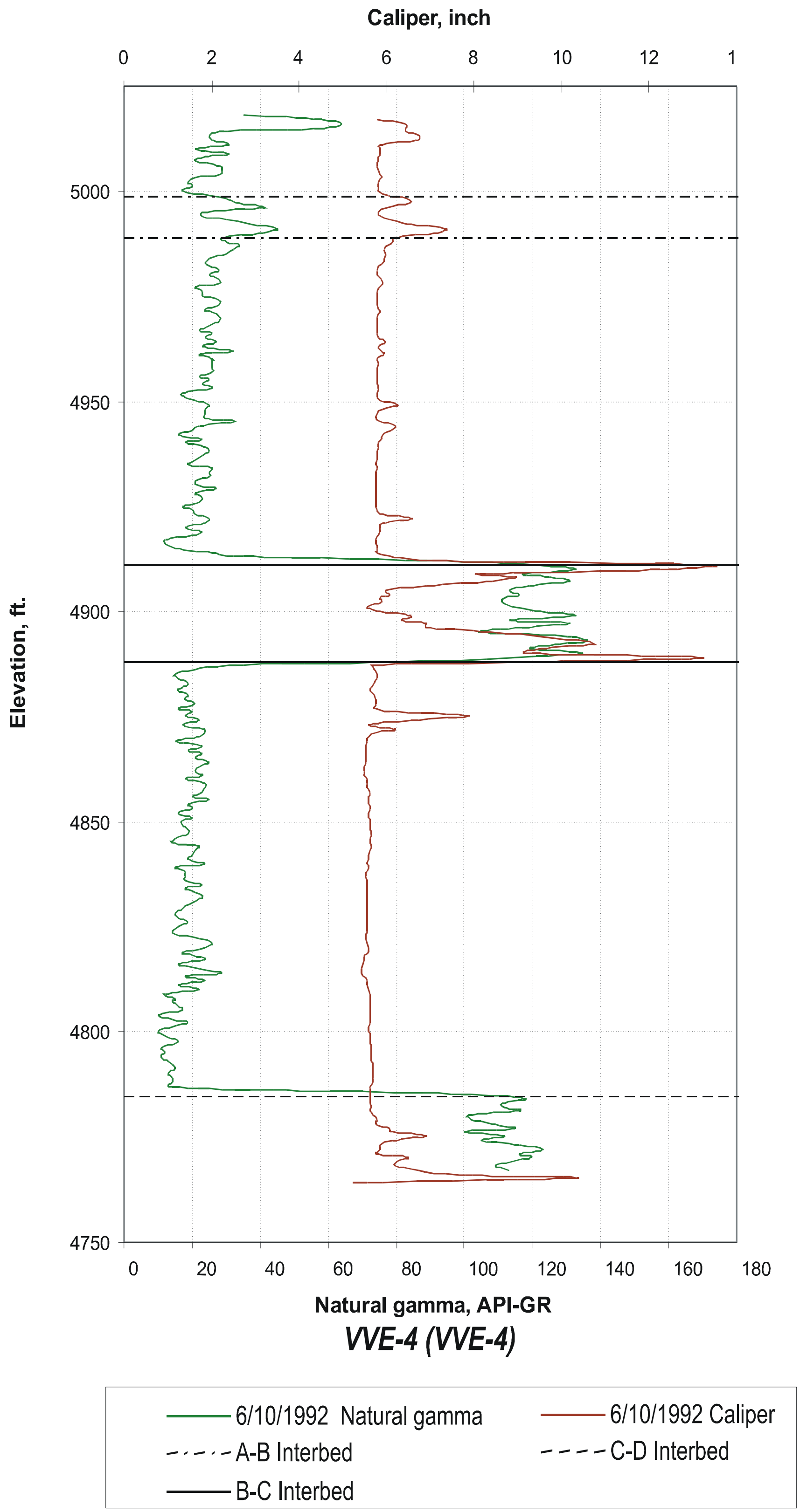
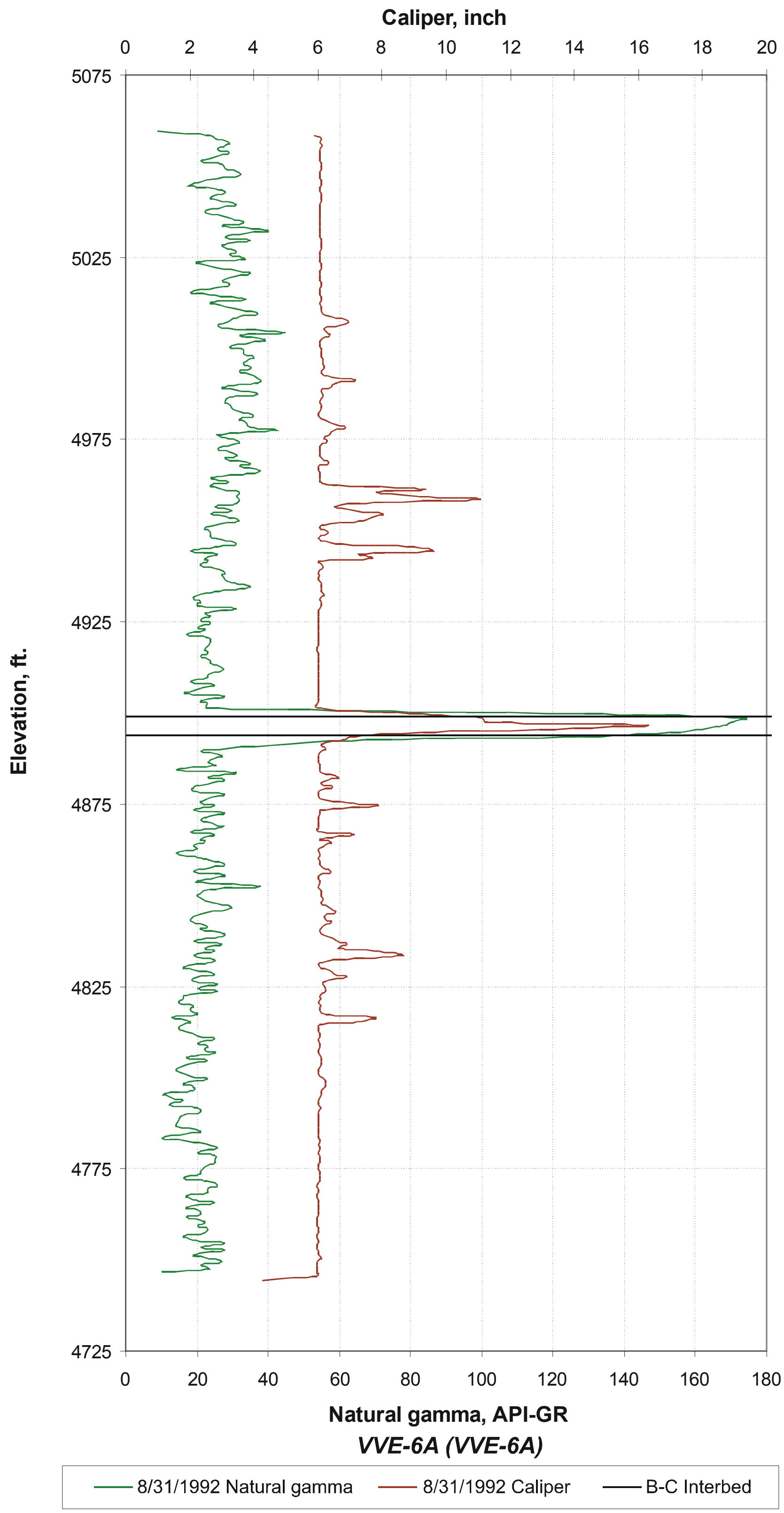


Figure C-4. Well VVE-4.



NOTE: C-D Interbed not selected because well not deep enough. Co-located well M6S has a C-D Interbed at 4746 feet elevation.

Figure C-5. Well VVE-6A.

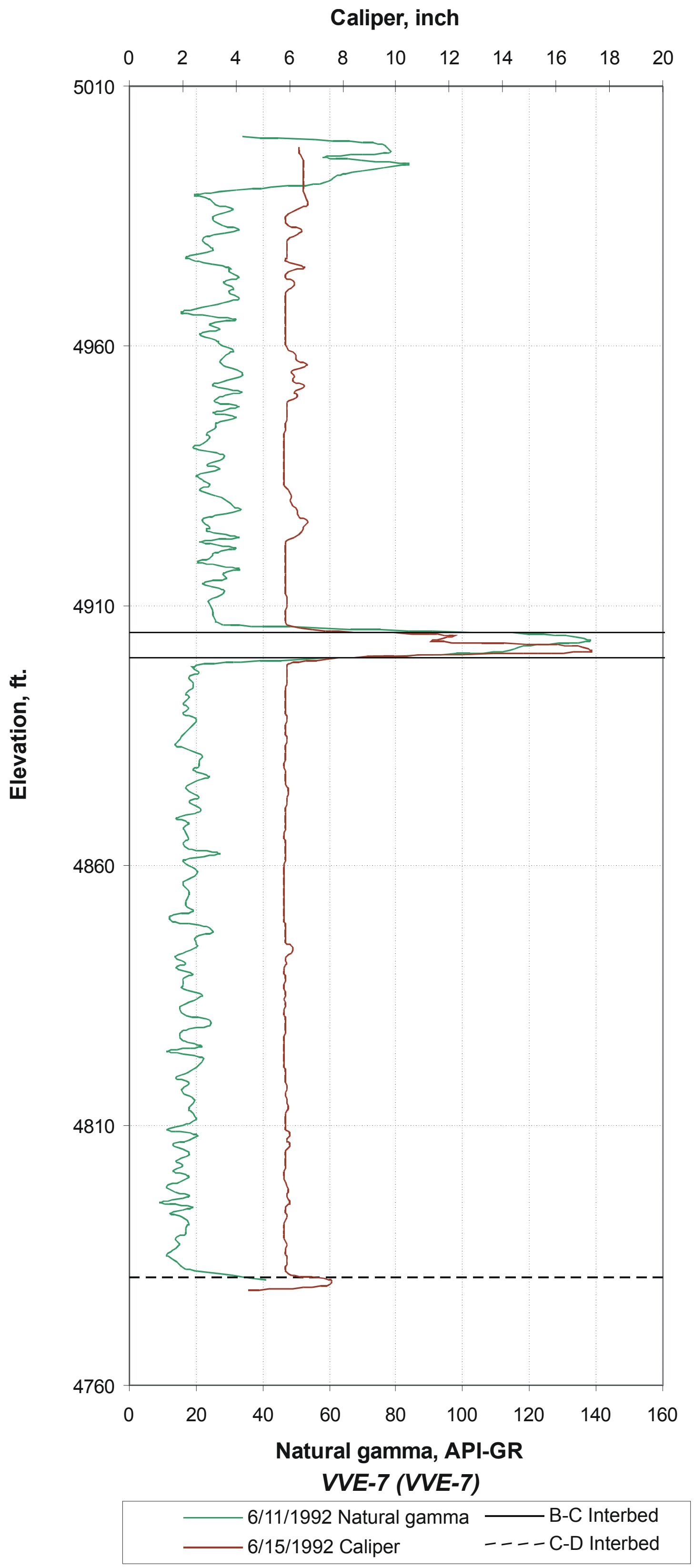


Figure C-6. Well VVE-7.

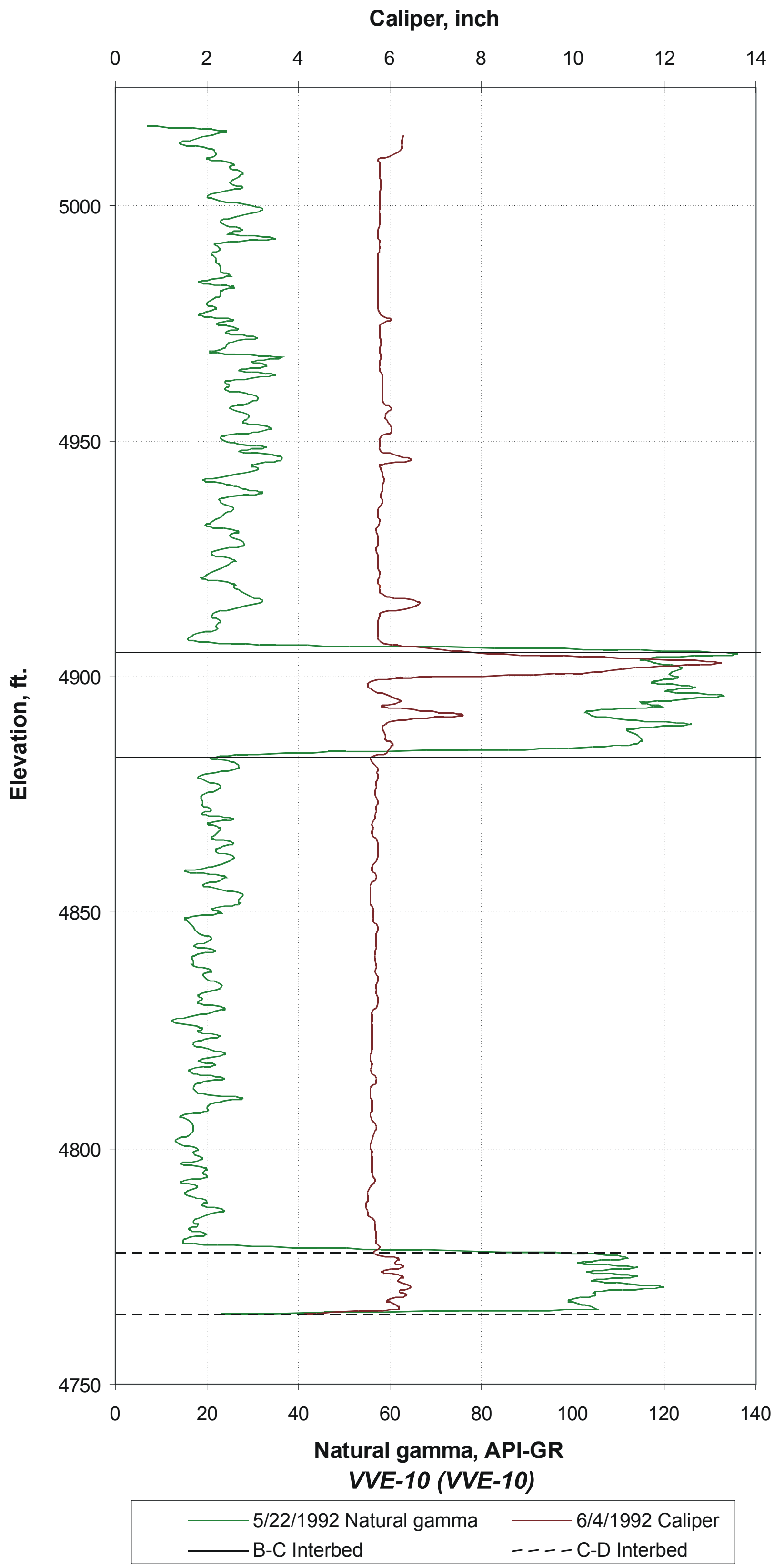


Figure C-7. Well VVE-10.

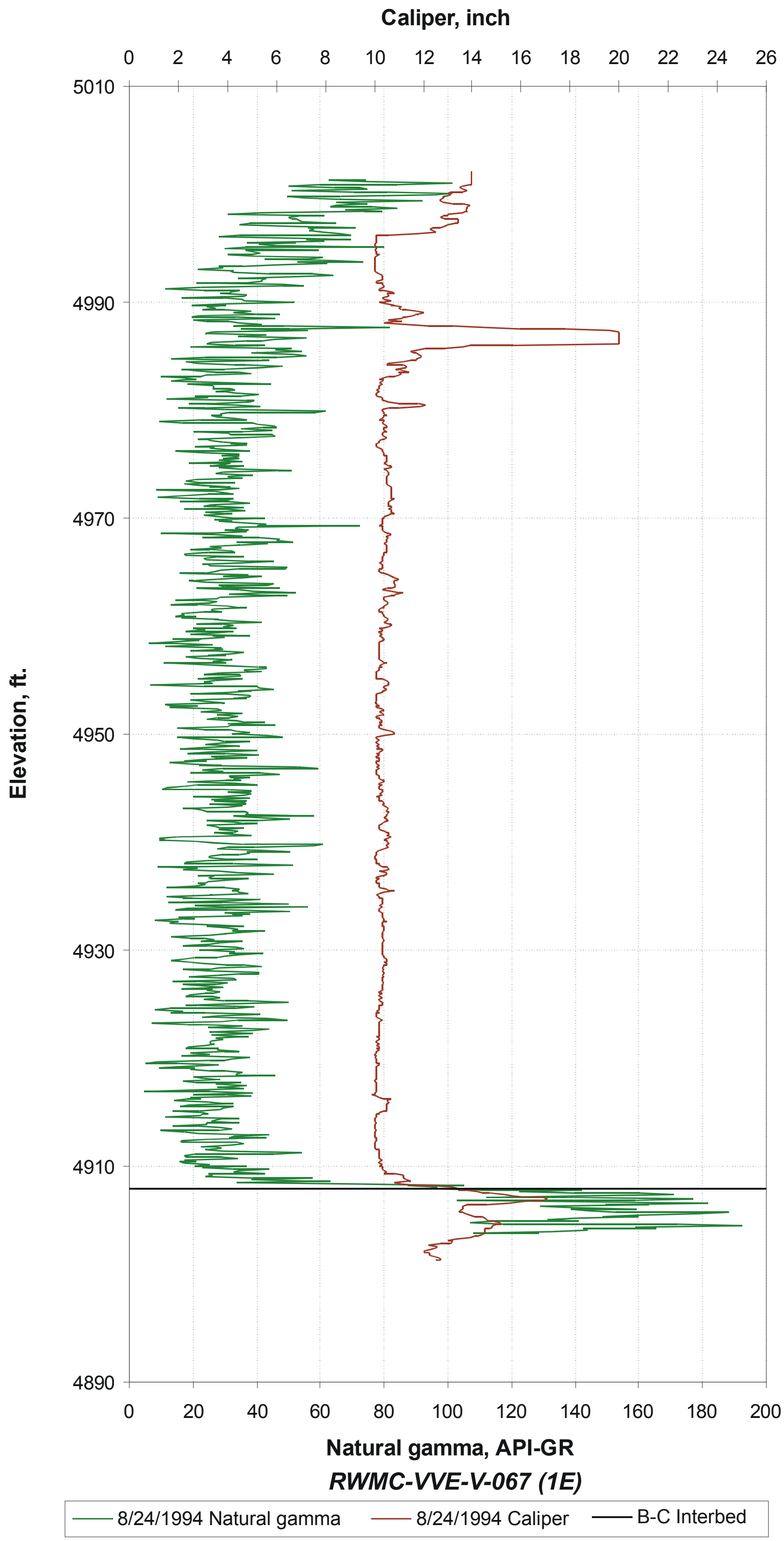


Figure C-8. Well RWMC-VVE-V-067 (1E).

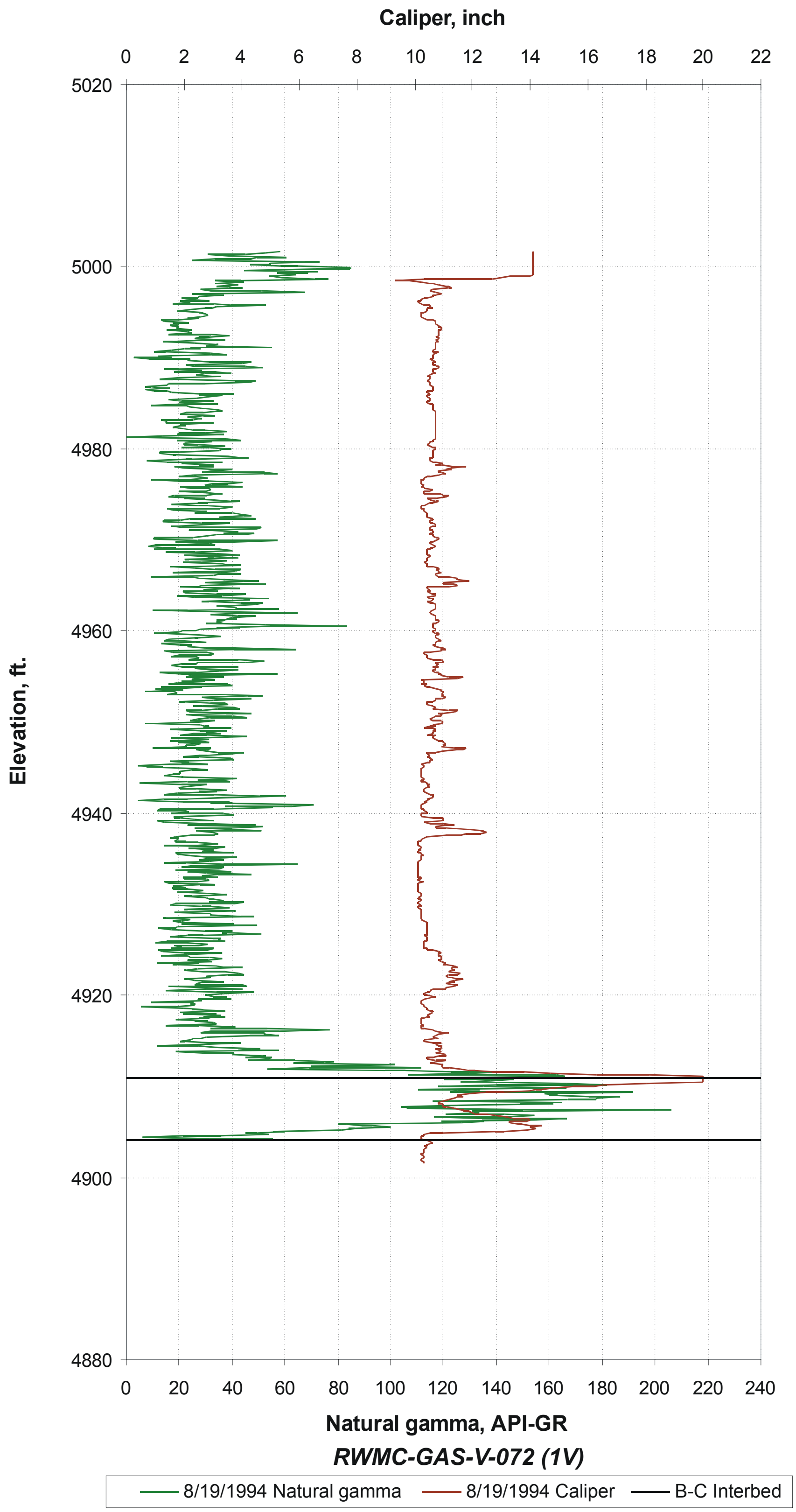


Figure C-9. Well RWMC-GAS-V-072 (1V).

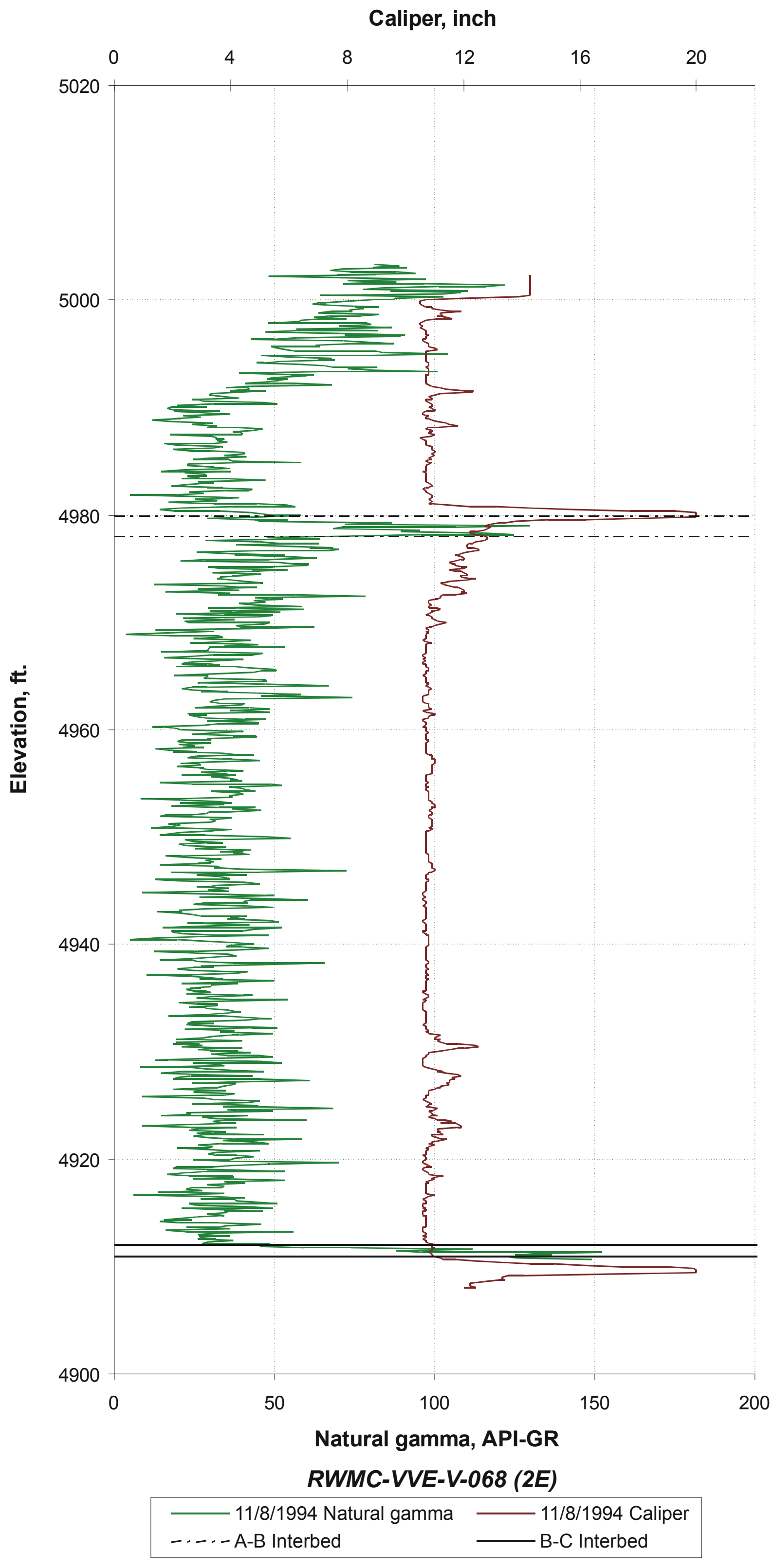


Figure C-10. Well RWMC-VVE-V-068 (2E).

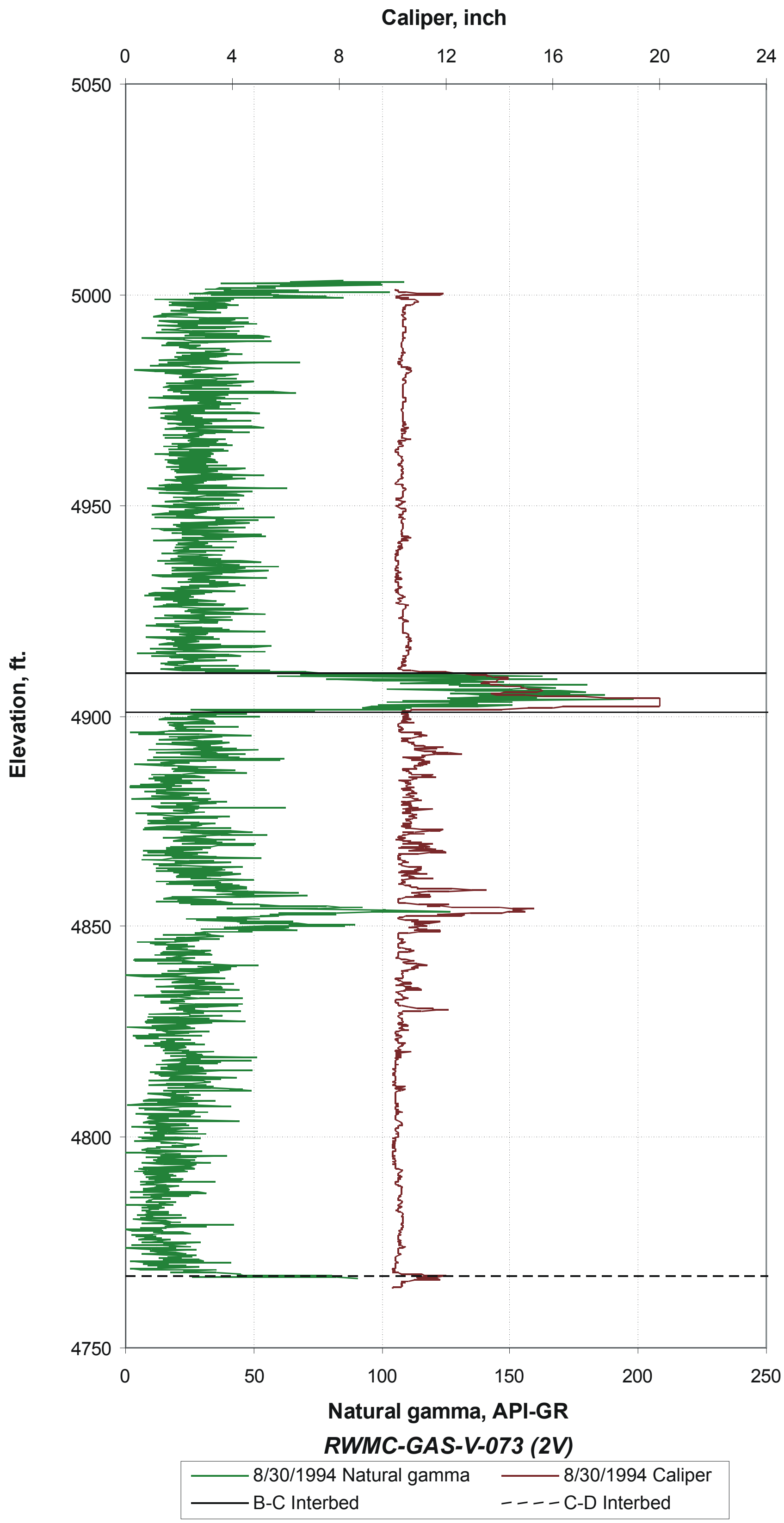


Figure C-11. Well RWMC-GAS-V-073 (2V).

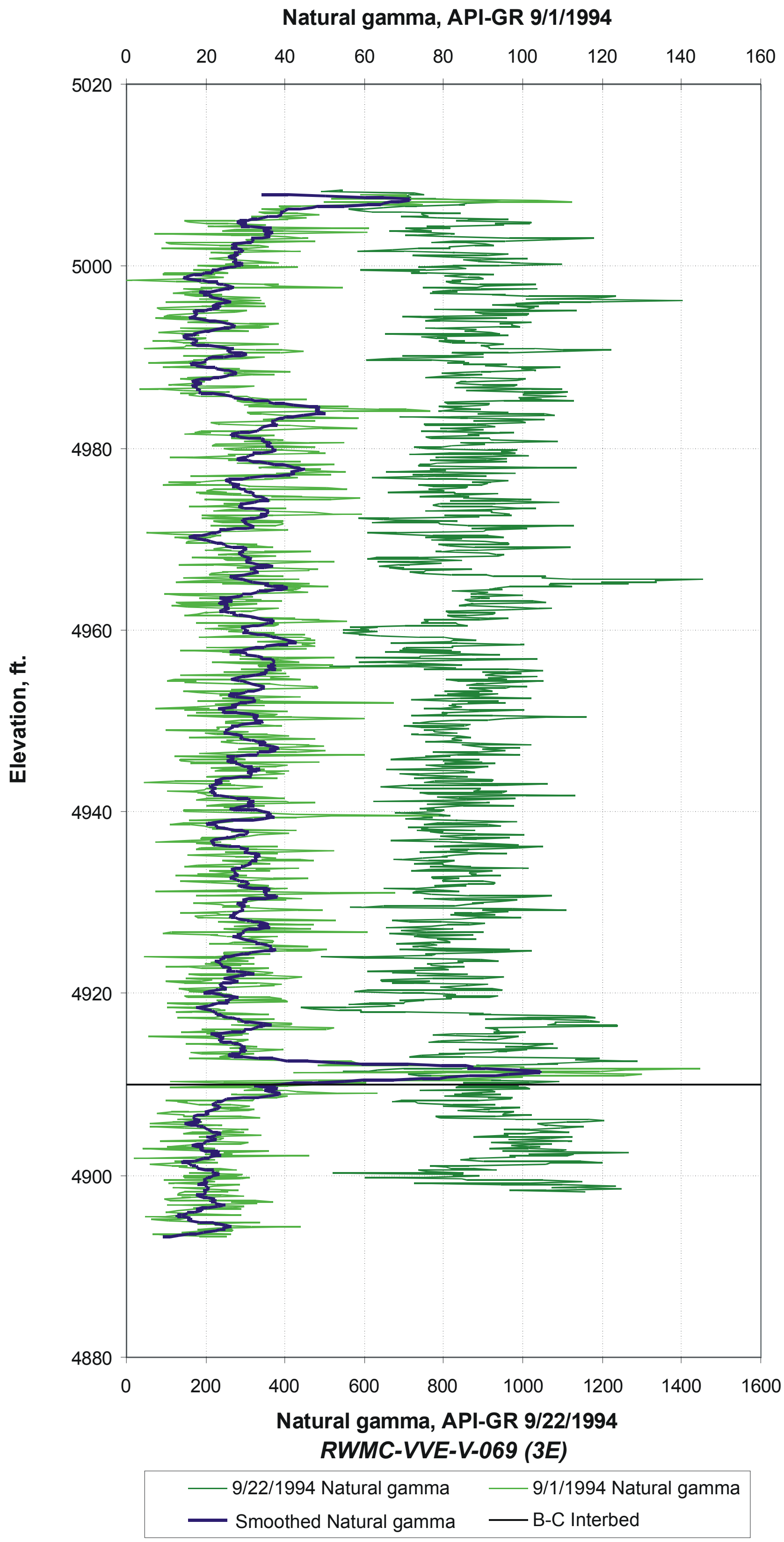


Figure C-12. Well RWMC-VVE-V-069 (3E).

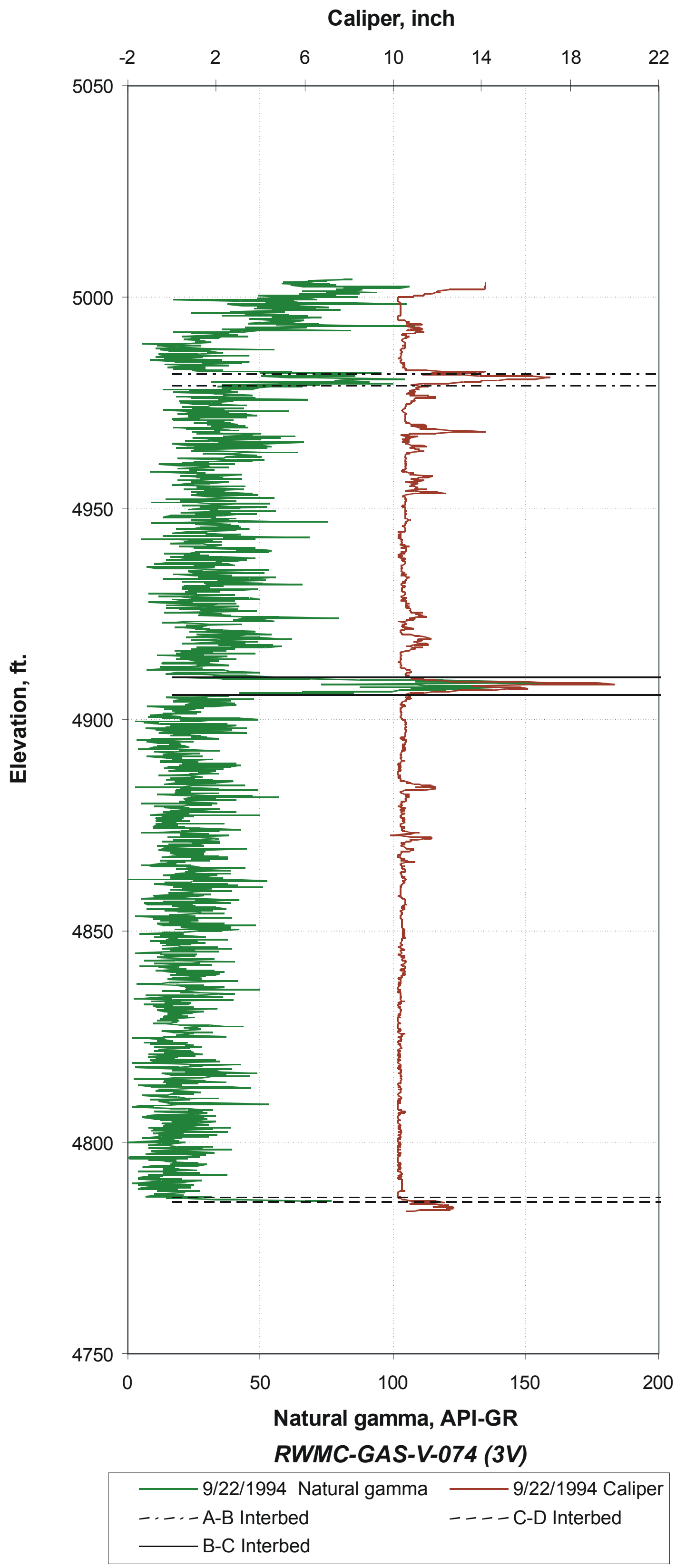


Figure C-13. Well RWMC-GAS-V-074 (3V).

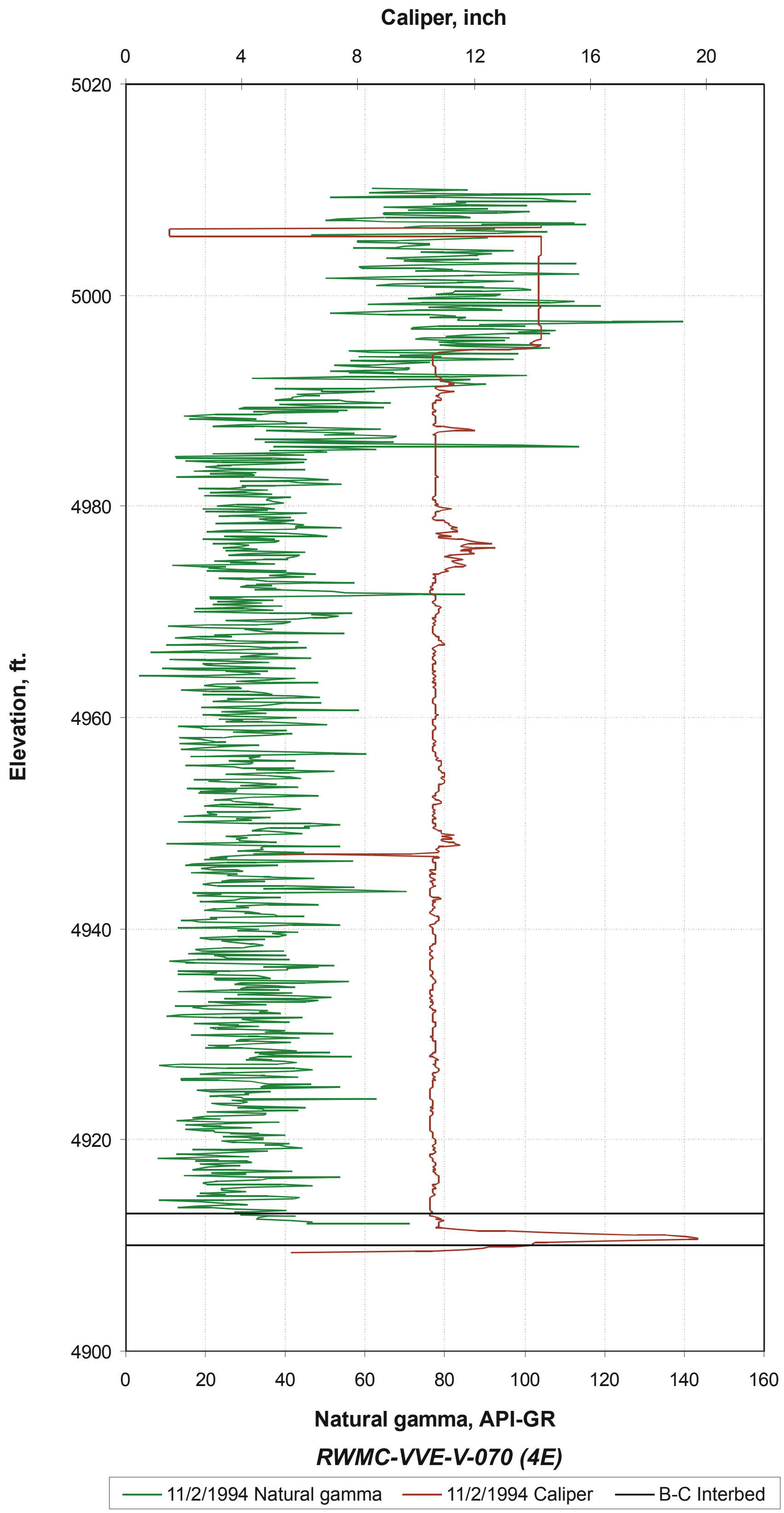


Figure C-14. Well RWMC-VVE-V-070 (4E).

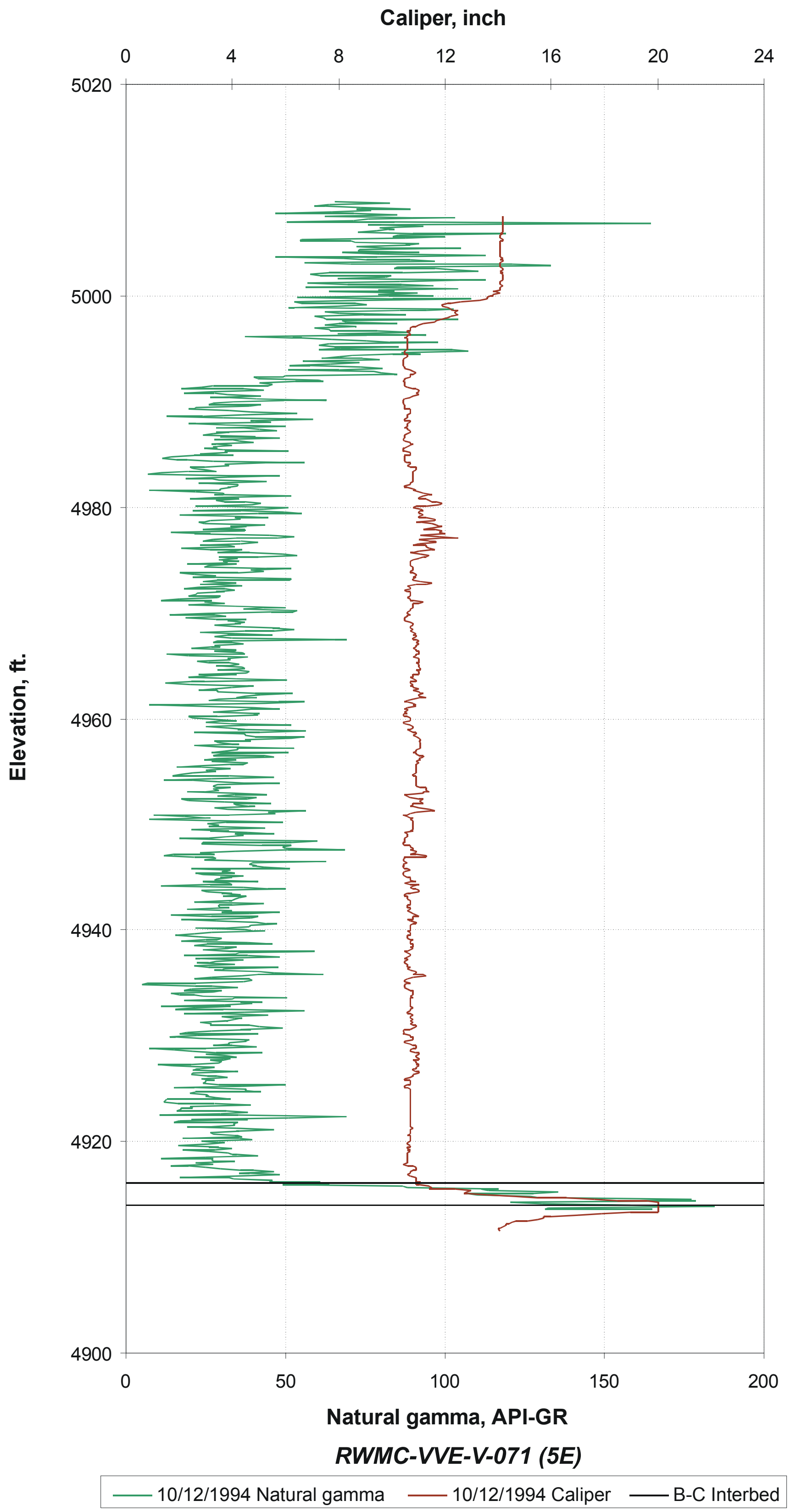


Figure C-15. Well RWMC-VVE-V-071 (5E).

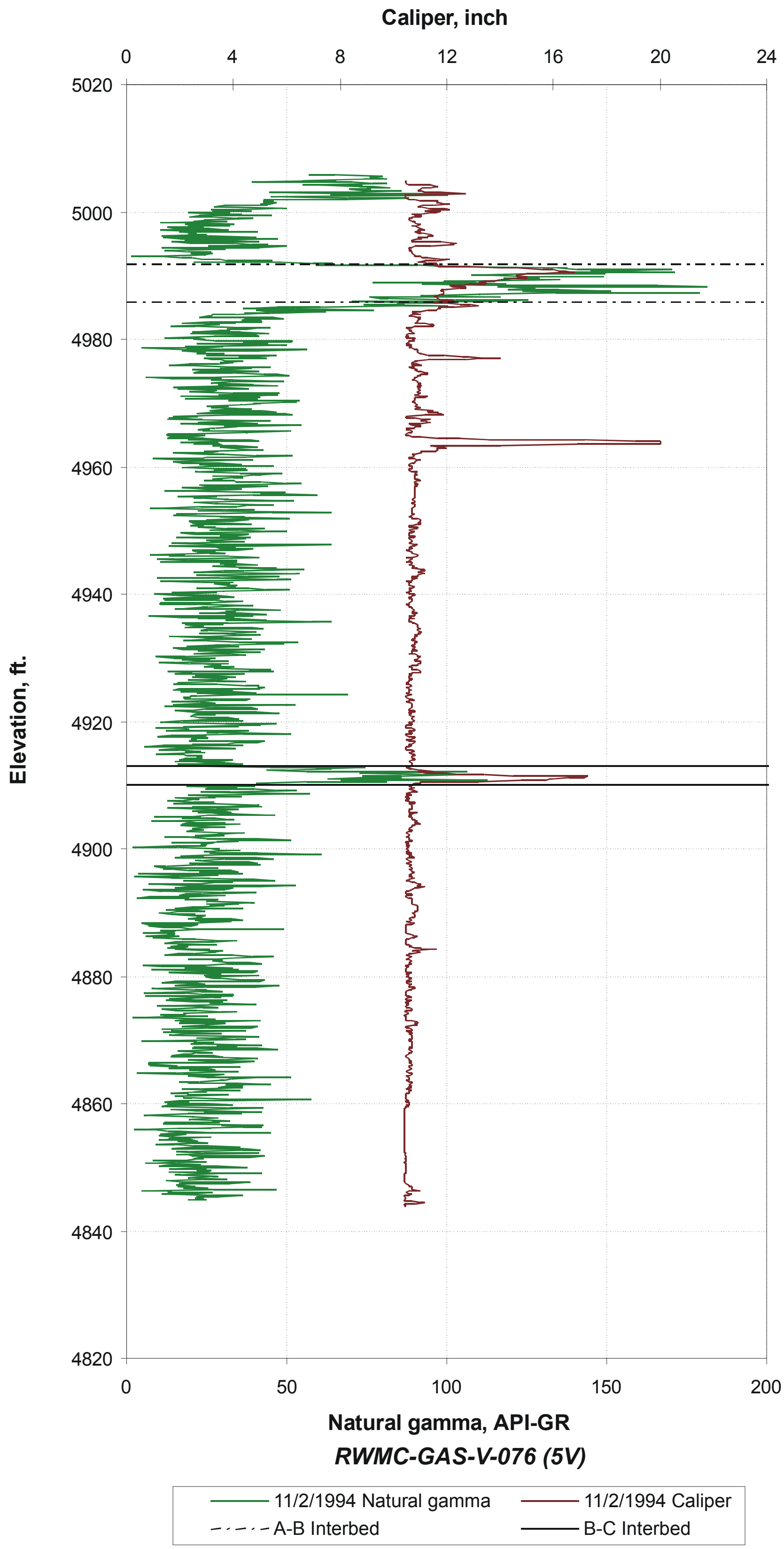


Figure C-16. Well RWMC-GAS-V-076 (5V).

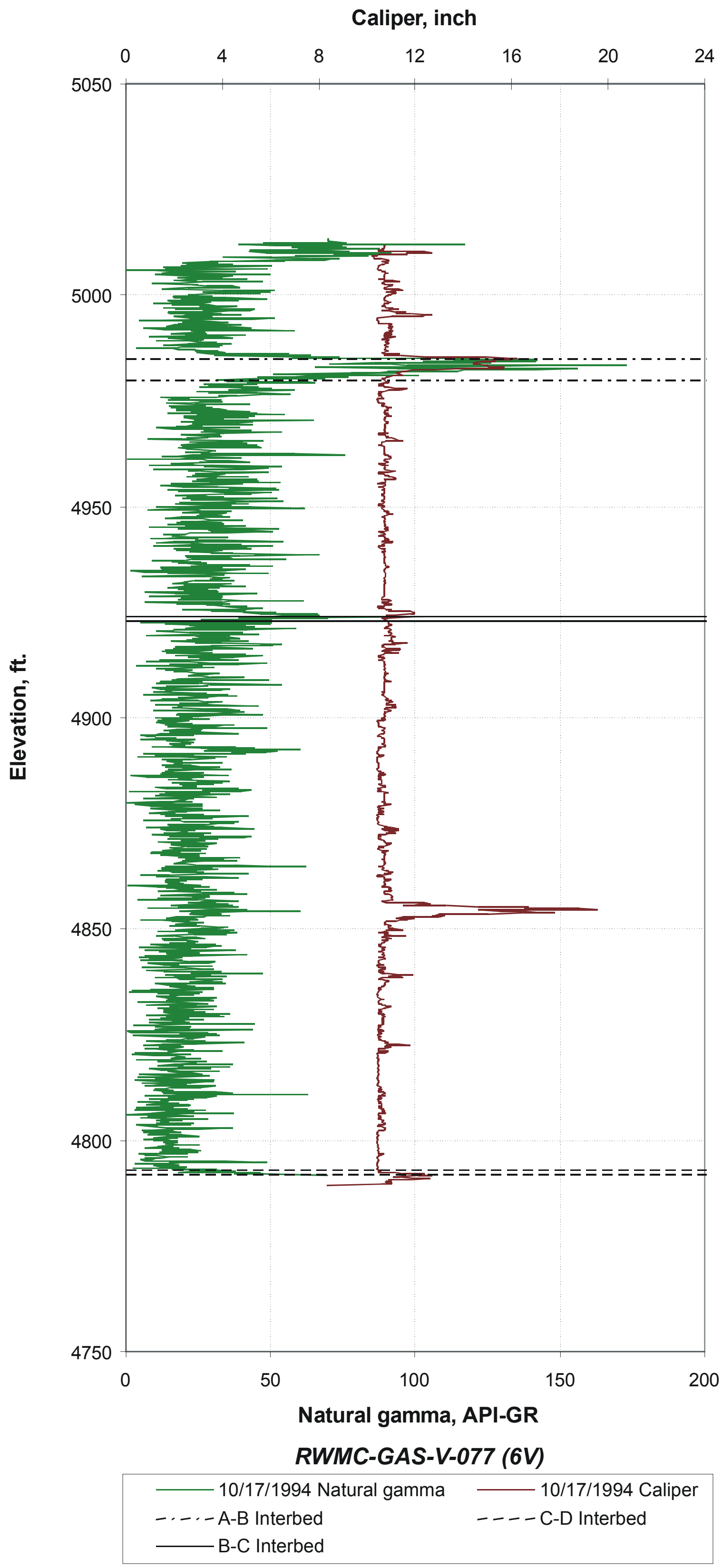


Figure C-17. Well RWMC-GAS-V-077 (6V).

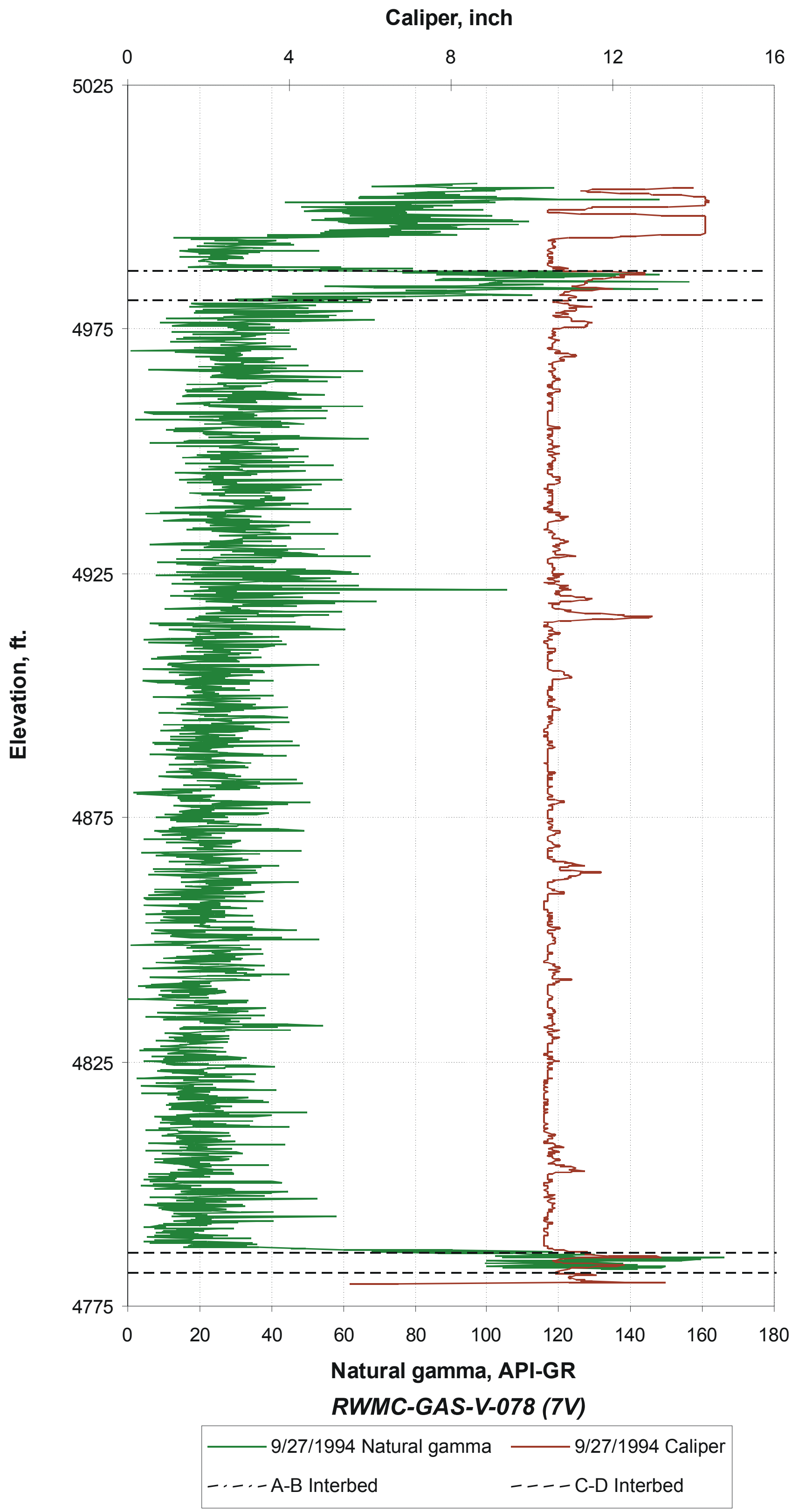


Figure C-18. Well RWMC-GAS-V-078 (7V).

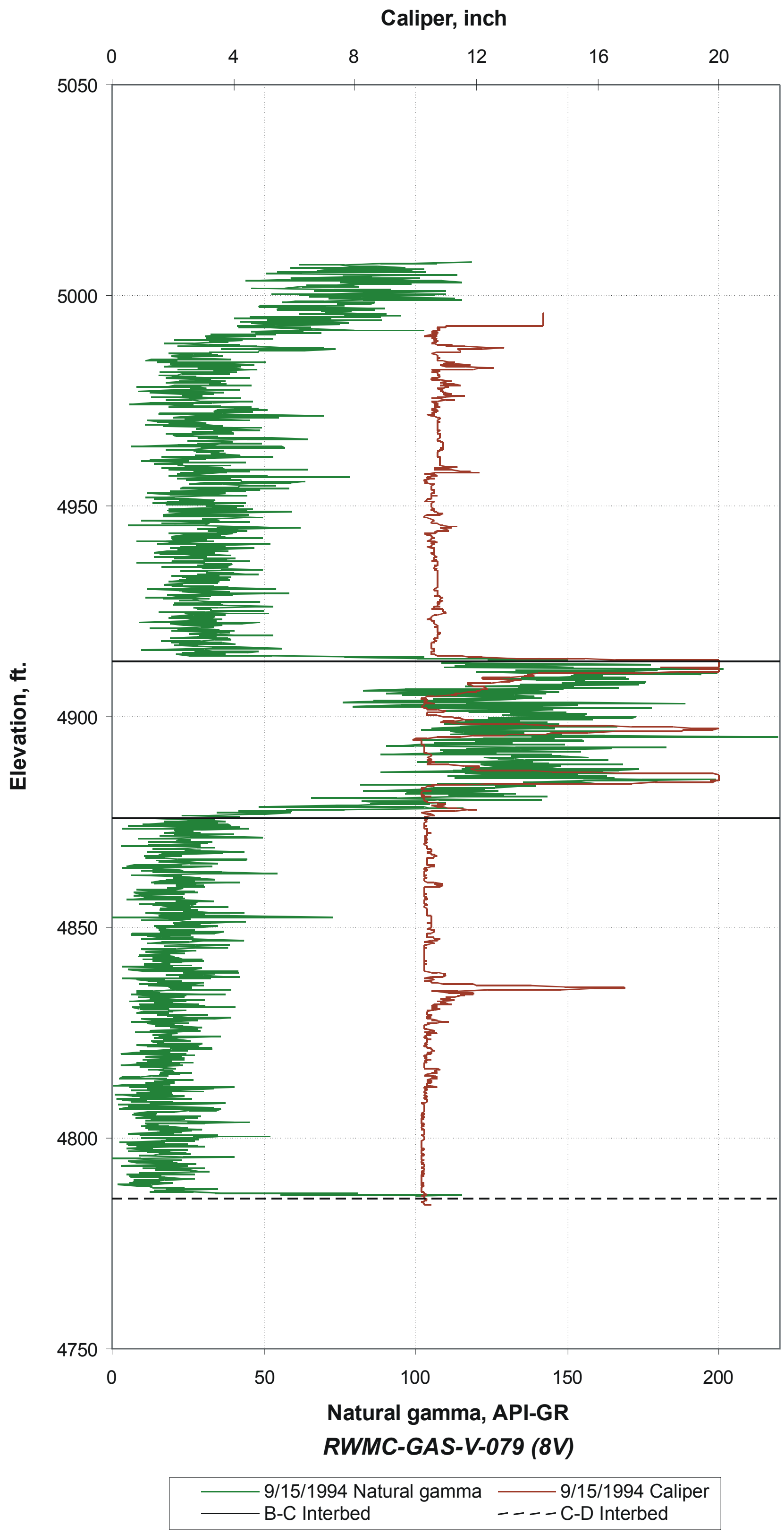


Figure C-19. Well RWMC-GAS-V-079 (8V).

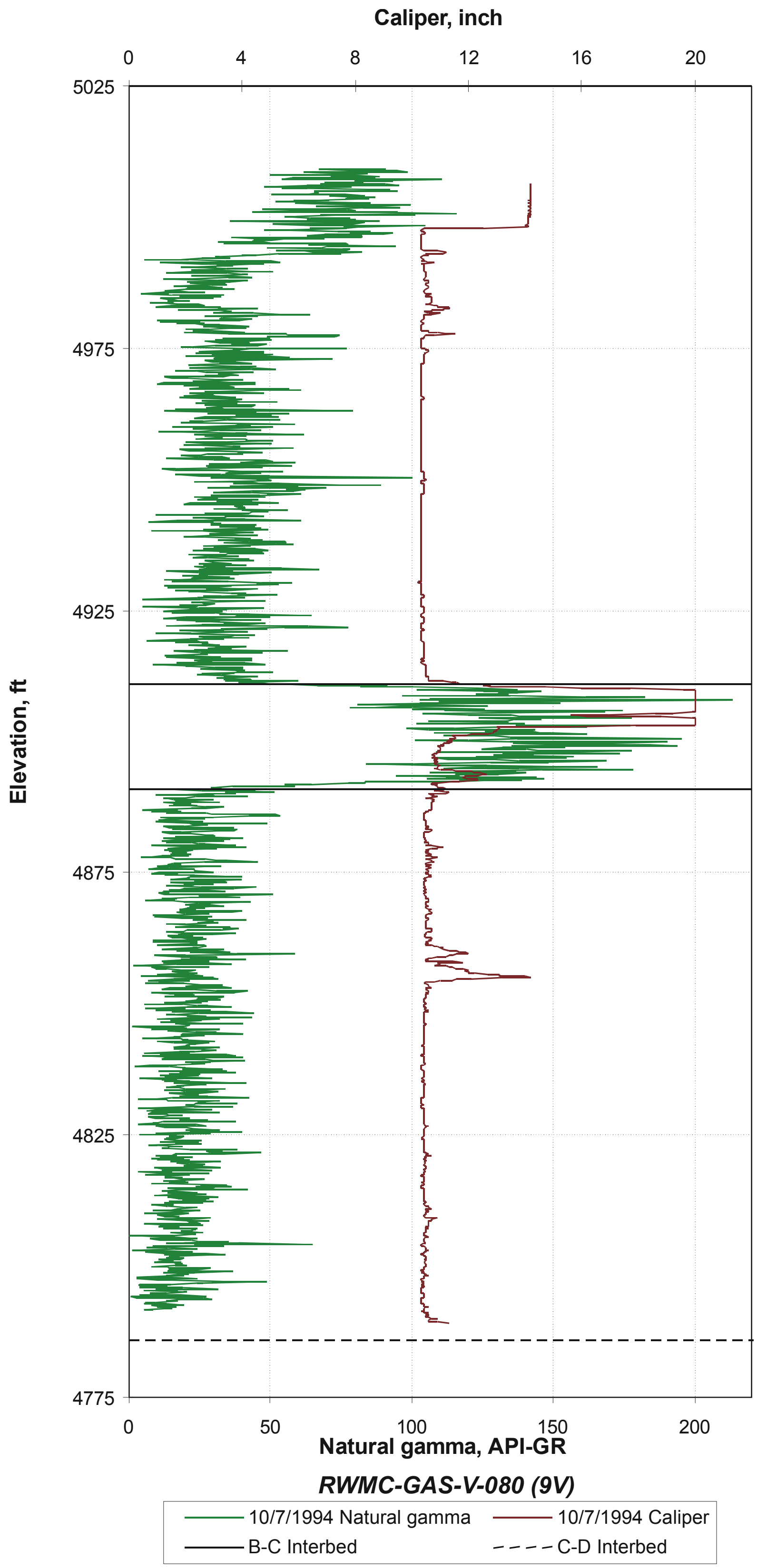


Figure C-20. Well RWMC-GAS-V-080 (9V).

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION
& ENVIRONMENTAL GROUP

HOLE ID: **10V**

Sheet 1 of 7

O-10V LOG
S-THE PHYS GPO

SUBCONTRACT: 607080

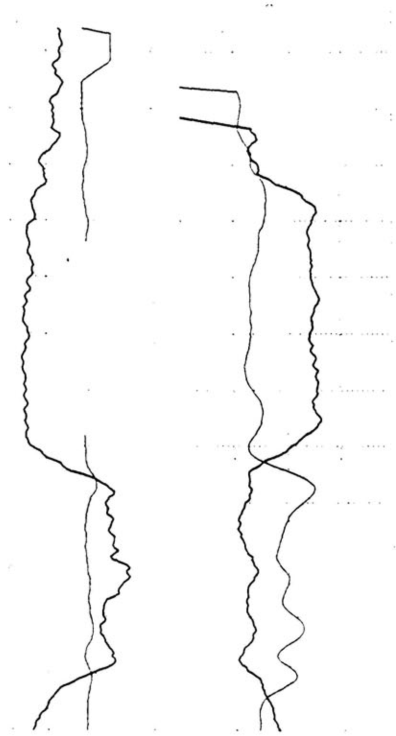
BOREHOLE LOG

PROJECT: OCVZ - RWMC OU 7-08	NUMBER: 0527	LOCATION: SDA NW CORNER, RWMC	
STAKED COORDINATES: 669,572.13N, 265,021.84E		DRILLING CONTRACTOR: PC EXPLORATION	GEOPHYSICAL LOGGER: USGS
DRILL METHOD -- MODEL: MOBILE B-53/CME-850/REICHDRILL T-650-W	DEPTH TOP OF ROCK: 10.0'	DEPTH CASING AND SIZES: 14" to 9.5'	
G.S. ELEV.:	TOC ELEV.: + 3'	BOREHOLE ANGLE: VERTICAL	
	TOTAL DEPTH: 232.0'	HOLE SIZE: 4" / 18" / 9 7/8"	
WATER DEPTH/DATE: --	FLUID AND ADDITIVES: AUGER/AIR	DATE START: 9/1/94	DATE FINISH: 10/13/94
GEOLOGIST (S): J. CERCONE/A. BENFER			

GEOPHYSICAL LOGS

Caliper (in) 0 – 20; Density (cps) 50,000 – 100,000

Nat. Gamma (API-GR) 0 – 200; Neutron (API-N) 1,000 – 5,000



SAMPLE | ELEVATION | DEPTH (feet) | GRAPHIC LOG

DESCRIPTION

LITHOLOGY, Color, Grain Size, Textures, Structures, Weathering, Alteration, Cementation, Hardness, or Minerology.

COMMENTS

Penetration rates, lost circulation zones, cementing zones, test zones, or tool changes.

Elevation / Depth	Description	Comments
0	SILT, light brown, dry, soft, loose. ML	Auger-drilled 0-10.0 feet.
2.5	GRAVELLY SILT, brown, slightly moist, dense, ~10% gravels, poorly sorted. ML	4" Auger-pilot hole. At this site 3-pilot holes drilled.
-5 — 5	SILT, brown, slightly moist, medium stiff. ML	Top of bedrock at 10'. 14" steel surface casing grouted to 9.5'. Begin 9 7/8" rev. circ. air rotary drilling at 10'. No returns 10'-14'. Cuttings samples collected every 5 feet to T.D.
8.3	SILT-CLAY, brown, moist, medium dense, low plasticity. ML-CL	
-10 — 10	BASALT, gray to dark gray, upper 1.5 feet weathered, basalt improves with depth, very fine grained.	
	Basalt, dark gray, moderate weathering, generally fresh olivene, relatively dense, cuttings fine to medium (~1/8").	
-15 — 15		3:30 - Moderate return.
		Dense.
-20 — 20	Finely vesicular, clear plagioclase, dense, olivene fresh and weathered, no oxidation, cuttings 1/8"-1/2".	3:47 - Good return. Hard.
	~50% silty fine sand, gray-brown, 50% dense basalt, fresh olivene.	Soft, hammer not firing.
-25 — 25	SANDY SILT TO SILTY SAND, fine grain silt orange, sand gray, brown, slightly moist, 30-foot interbed, exceptionally thick.	3:53 - Soft. 26'-27' - Void.
-30 — 30		

Figure C-21. Boreholl Log 10 V, Sheet 1.

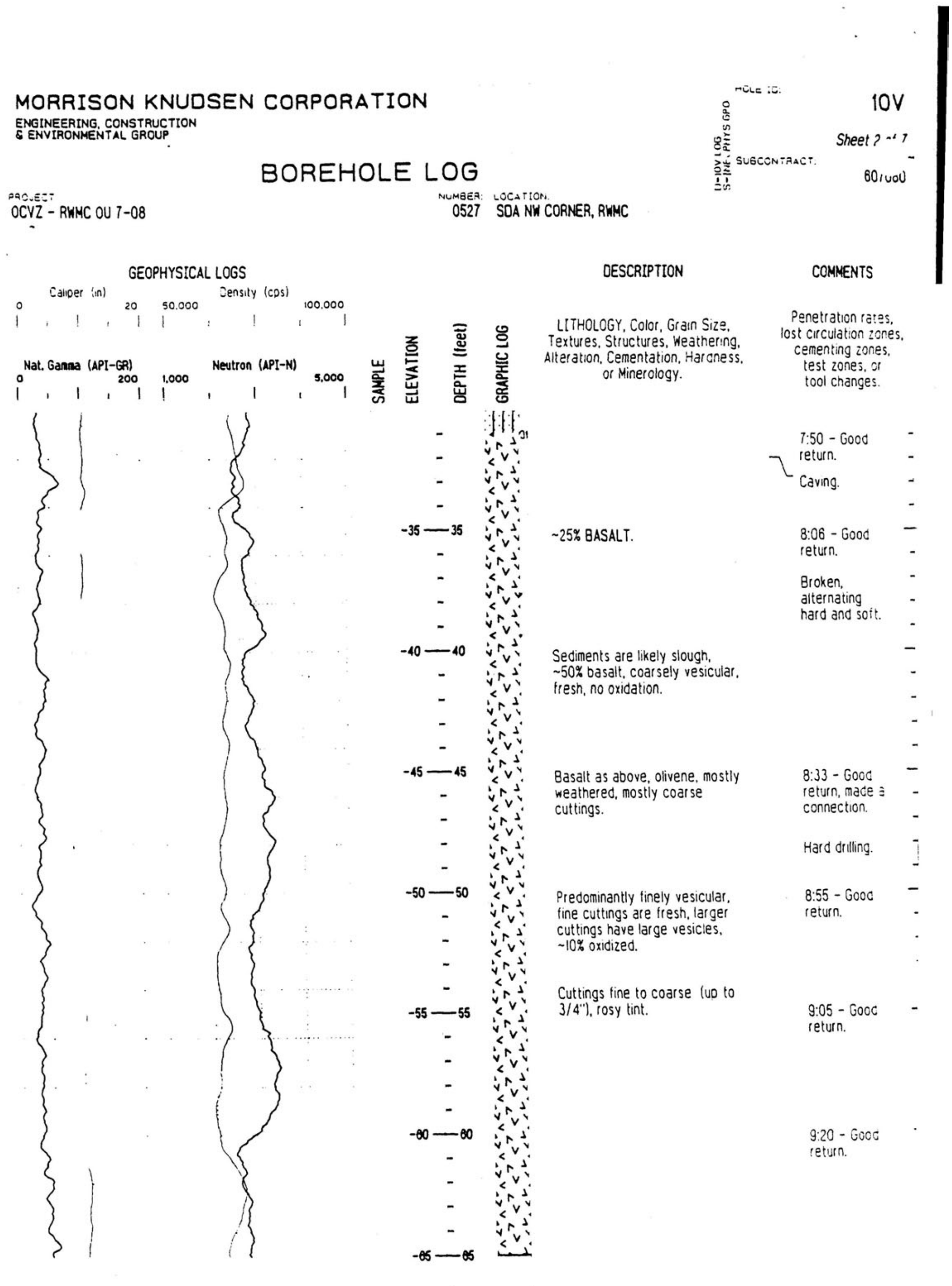
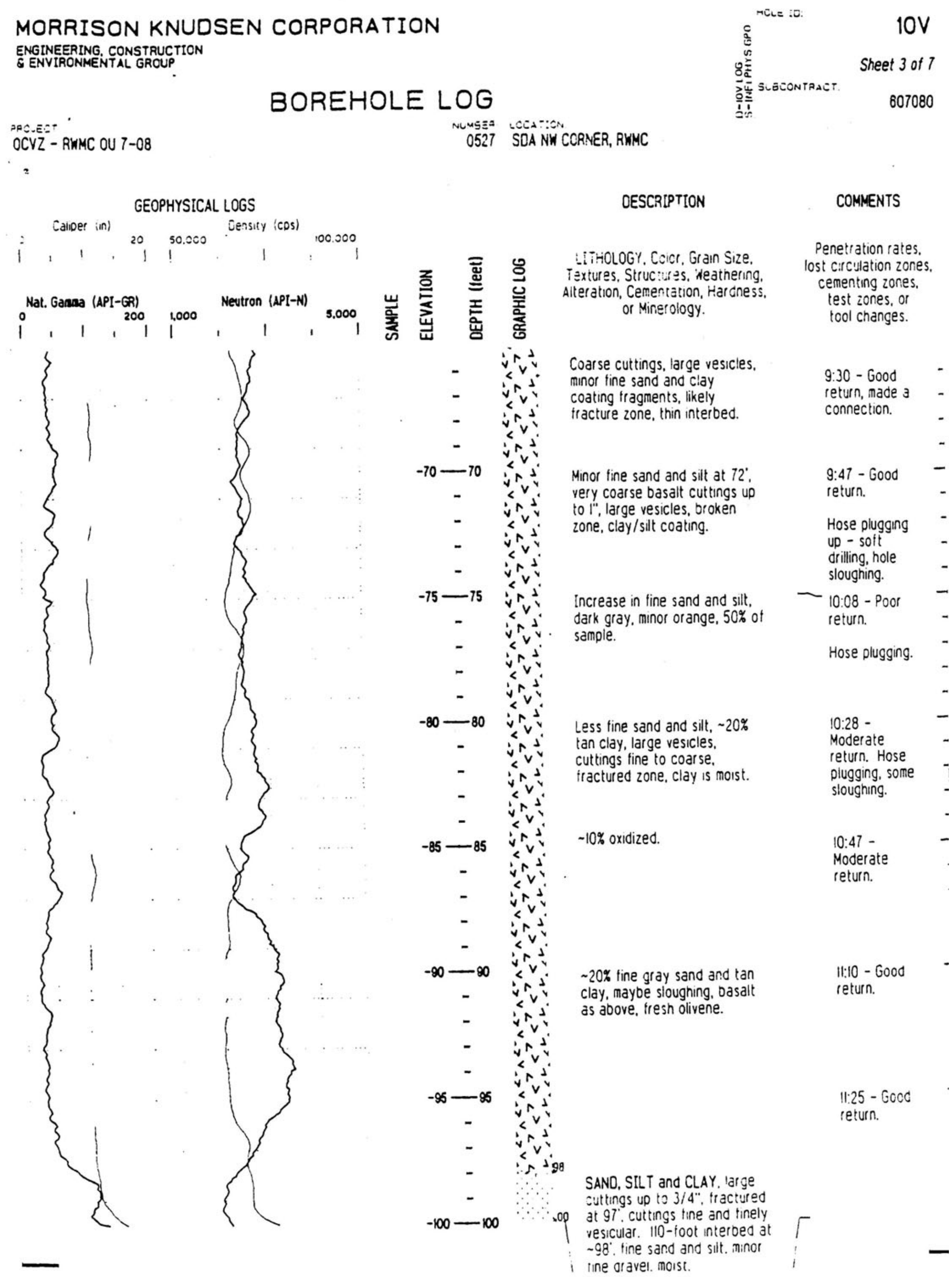


Figure C-22. Boreholl Log 10 V, Sheet 2.



MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION & ENVIRONMENTAL GROUP

BOREHOLE LOG

HOLE ID: 10V
Sheet 3 of 7
SUBCONTRACT: 807080

PROJECT: OCVZ - RWMC OU 7-08
NUMBER: 0527
LOCATION: SDA NW CORNER, RWMC

GEOPHYSICAL LOGS
Caliper (in) 20
Density (cps) 50,000 100,000
Nat. Gamma (API-GR) 0 200
Neutron (API-N) 1,000 5,000

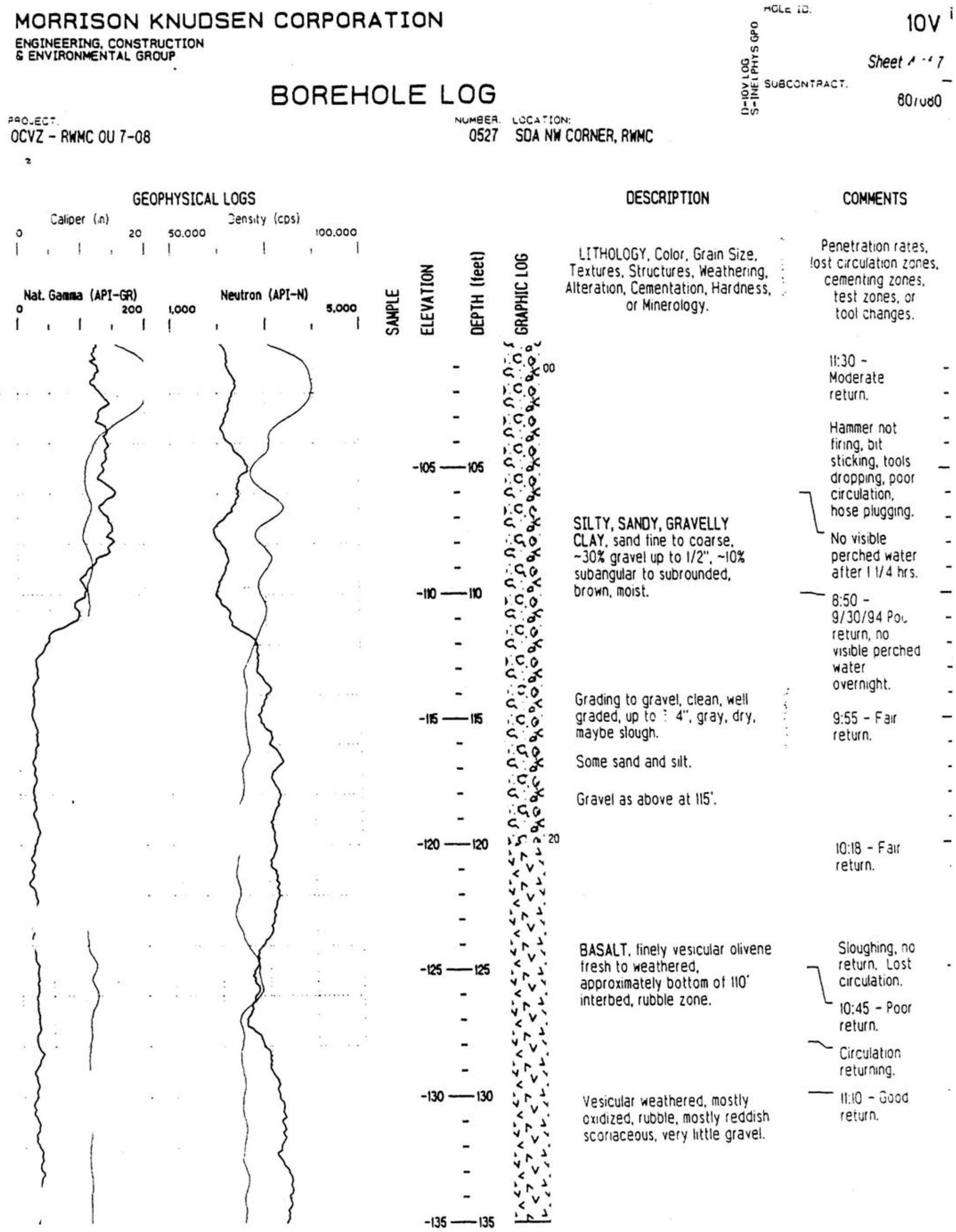
SAMPLE | ELEVATION | DEPTH (feet) | GRAPHIC LOG

DESCRIPTION: LITHOLOGY, Color, Grain Size, Textures, Structures, Weathering, Alteration, Cementation, Hardness, or Minerology.

COMMENTS: Penetration rates, lost circulation zones, cementing zones, test zones, or tool changes.

Elevation / Depth	Description	Comments
	Coarse cuttings, large vesicles, minor fine sand and clay coating fragments, likely fracture zone, thin interbed.	9:30 - Good return, made a connection.
-70 / 70	Minor fine sand and silt at 72', very coarse basalt cuttings up to 1", large vesicles, broken zone, clay/silt coating.	9:47 - Good return. Hose plugging up - soft drilling, hole sloughing.
-75 / 75	Increase in fine sand and silt, dark gray, minor orange, 50% of sample.	10:08 - Poor return. Hose plugging.
-80 / 80	Less fine sand and silt, ~20% tan clay, large vesicles, cuttings fine to coarse, fractured zone, clay is moist.	10:28 - Moderate return. Hose plugging, some sloughing.
-85 / 85	~10% oxidized.	10:47 - Moderate return.
-90 / 90	~20% fine gray sand and tan clay, maybe sloughing, basalt as above, fresh olivene.	11:10 - Good return.
-95 / 95		11:25 - Good return.
98	SAND, SILT and CLAY, large cuttings up to 3/4", fractured at 97', cuttings fine and finely vesicular. 110-foot interbed at ~98', fine sand and silt, minor fine gravel, moist.	
-100 / 100		

Figure C-23. Boreholl Log 10 V, Sheet 3.



MORRISON KNUDSEN CORPORATION

ENGINEERING, CONSTRUCTION
& ENVIRONMENTAL GROUP

BOREHOLE LOG

HOLE ID: 10V

Sheet 4 of 7

SUBCONTRACT: 80/080

PROJECT: OCVZ - RWMC OU 7-08

NUMBER: 0527

LOCATION: SDA NW CORNER, RWMC

GEOPHYSICAL LOGS

Caliper (in) 0 20

Density (cps) 50,000 100,000

Nat. Gamma (API-GR) 0 200

Neutron (API-N) 1,000 5,000

SAMPLE | ELEVATION | DEPTH (feet) | GRAPHIC LOG

DESCRIPTION

LITHOLOGY, Color, Grain Size, Textures, Structures, Weathering, Alteration, Cementation, Hardness, or Minerology.

COMMENTS

Penetration rates, lost circulation zones, cementing zones, test zones, or tool changes.

Elevation	Depth (feet)	Description	Comments
			11:30 - Moderate return.
-105	105		Hammer not firing, bit sticking, tools dropping, poor circulation, hose plugging.
		SILTY, SANDY, GRAVELLY CLAY, sand fine to coarse, ~30% gravel up to 1/2", ~10% subangular to subrounded, brown, moist.	No visible perched water after 1 1/4 hrs.
-110	110		8:50 - 9/30/94 Poor return, no visible perched water overnight.
-115	115	Grading to gravel, clean, well graded, up to 4", gray, dry, maybe slough.	9:55 - Fair return.
		Some sand and silt.	
		Gravel as above at 115'.	
-120	120		10:18 - Fair return.
-125	125	BASALT, finely vesicular olivene fresh to weathered, approximately bottom of 110' interbed, rubble zone.	Sloughing, no return. Lost circulation.
			10:45 - Poor return.
			Circulation returning.
-130	130	Vesicular weathered, mostly oxidized, rubble, mostly reddish scoriaceous, very little gravel.	11:10 - Good return.
-135	135		

Figure C-24. Boreholl Log 10 V, Sheet 4.

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION
& ENVIRONMENTAL GROUP

HOLE ID: **10V**
Sheet 5 of 7
SUBCONTRACT: 607080

U-10V LOG
S-INEL PHYS GPO

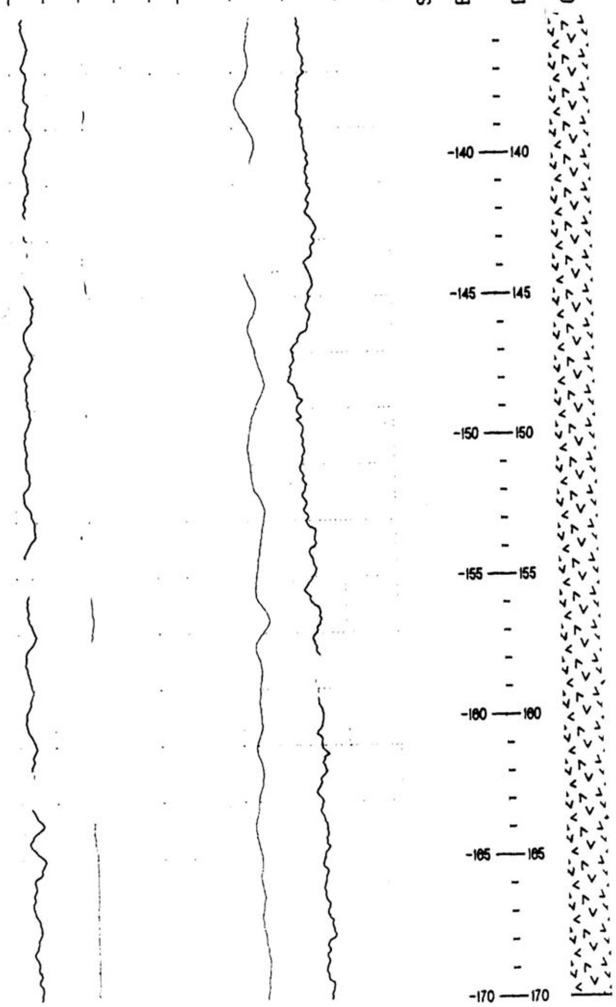
BOREHOLE LOG

PROJECT: OCVZ - RWMC OU 7-08
NUMBER: 0527
LOCATION: SDA NW CORNER, RWMC

GEOPHYSICAL LOGS

Caliper (in) 0 — 20; Density (cps) 50,000 — 100,000
Nat. Gamma (API-GR) 0 — 200; Neutron (API-N) 1,000 — 5,000

SAMPLE | ELEVATION | DEPTH (feet) | GRAPHIC LOG



ELEVATION	DEPTH (feet)	DESCRIPTION LITHOLOGY, Color, Grain Size, Textures, Structures, Weathering, Alteration, Cementation, Hardness, or Minerology.	COMMENTS Penetration rates, lost circulation zones, cementing zones, test zones, or tool changes.
		Weathered as above, cuttings coarse.	11:25 - Good return.
-140	140	Rosy tint, olivene weathered, minor fine vesicules, ~10% strongly oxidized.	11:38 - Good return.
-145	145	Olivene still weathered, rosy.	11:48 - Good return.
-150	150	Less weathered, mostly fine cuttings.	1:15 - Good return.
-155	155	Olivene weathered, ~10% oxidized, mostly fine.	1:35 - Good return.
-160	160	Mostly non-vesicular, olivene weathered.	1:50 - Good return.
-165	165	Very finely vesicular, olivene still altered, <10% oxidized, slight rosy tint.	2:00 - Good return, made a connection.
-170	170		

Figure C-25. Boreholl Log 10 V, Sheet 5.

MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION & ENVIRONMENTAL GROUP

HOLE ID: 10V

D-10V LOG S-INEL PHYS GPO

Sheet 6 of 7

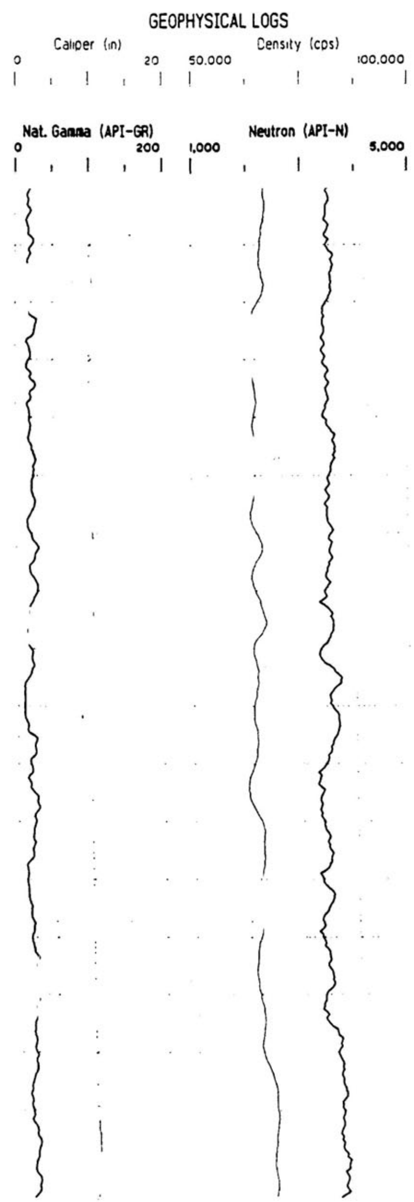
SUBCONTRACT: 80/080

BOREHOLE LOG

PROJECT: OCVZ - RWMC OU 7-08

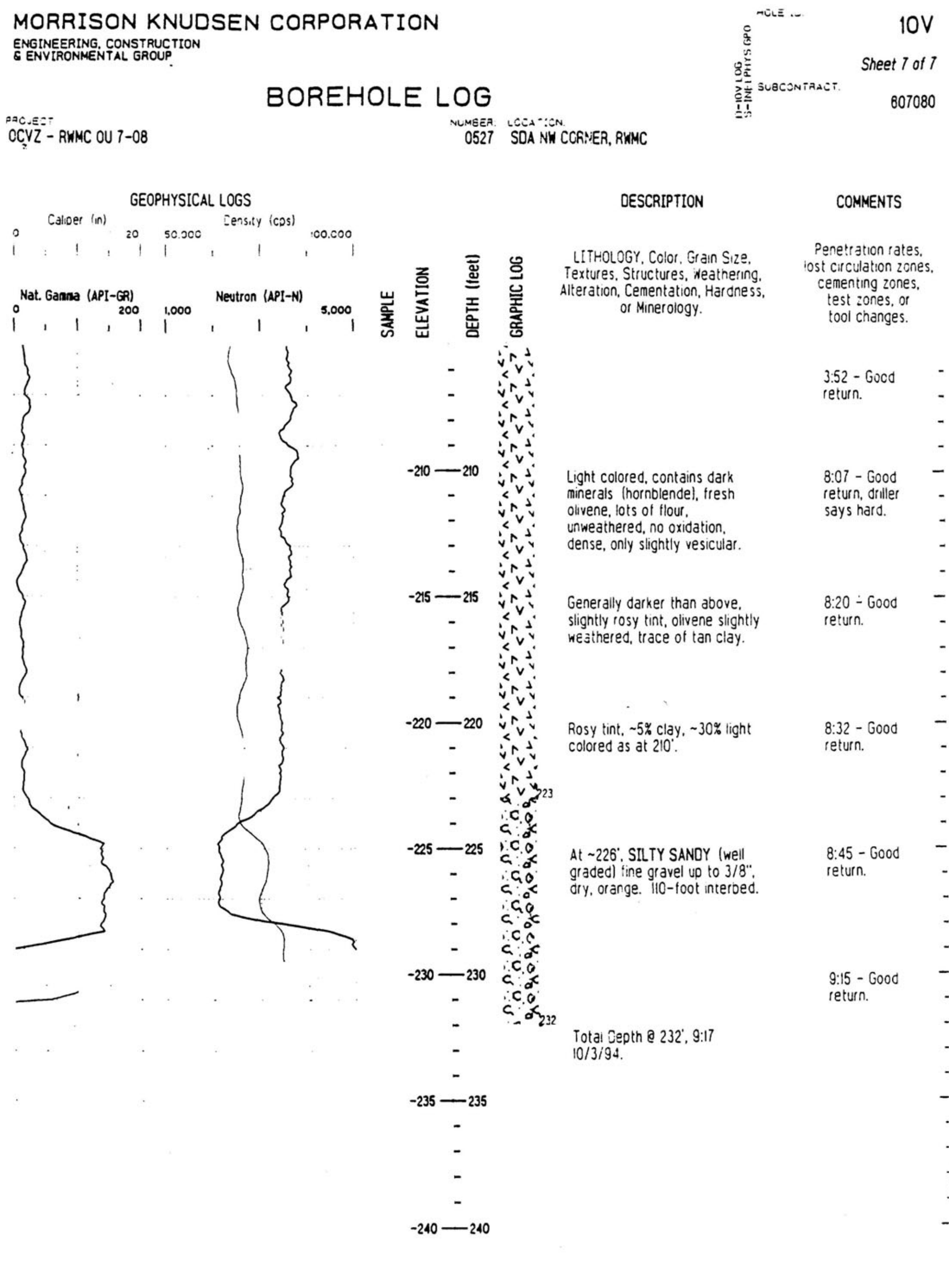
NUMBER: 0527

LOCATION: SDA NW CORNER, RWMC



SAMPLE	ELEVATION	DEPTH (feet)	DESCRIPTION: LITHOLOGY, Color, Grain Size, Textures, Structures, Weathering, Alteration, Cementation, Hardness, or Minerology.	COMMENTS: Penetration rates, lost circulation zones, cementing zones, test zones, or tool changes.
			Olivene fresh to altered, finely vesicular, less oxidation.	2:20 - Good return.
	-175	175	Clear plagioclase, some fine gray sand.	2:35 - Good return.
	-180	180	Maybe slightly more fine sand.	2:45 - Good return.
	-185	185	Olivene-rich, fresh, some fragments light colored, trace fine sand, light colored plagioclase, phaneritic.	2:55 - Good return.
	-190	190	Mostly light colored as above.	3:15 - Good return.
	-195	195	Cuttings fine, dense, some rock flour.	3:25 - Good return.
	-200	200	Still olivene and light colored, plagioclase rich, more rock flour.	3:40 - Good return.
	-205	205	Dense.	

Figure C-26. Boreholl Log 10 V, Sheet 6.



MORRISON KNUDSEN CORPORATION
ENGINEERING, CONSTRUCTION & ENVIRONMENTAL GROUP

HOLE NO. 10V
Sheet 7 of 7
SUBCONTRACT. 607080

BOREHOLE LOG

PROJECT: OCVZ - RWMC OU 7-08
NUMBER: 0527
LOCATION: SDA NW CORNER, RWMC

GEOPHYSICAL LOGS
Caliper (in) 0 – 20; Density (cps) 50,000 – 100,000
Nat. Gamma (API-GR) 0 – 200; Neutron (API-N) 1,000 – 5,000

SAMPLE | ELEVATION | DEPTH (feet) | GRAPHIC LOG

DESCRIPTION: LITHOLOGY, Color, Grain Size, Textures, Structures, Weathering, Alteration, Cementation, Hardness, or Minerology.

COMMENTS: Penetration rates, lost circulation zones, cementing zones, test zones, or tool changes.

Depth (feet)	Description	Comments
		3:52 - Good return.
210	Light colored, contains dark minerals (hornblende), fresh olivene, lots of flour, unweathered, no oxidation, dense, only slightly vesicular.	8:07 - Good return, driller says hard.
215	Generally darker than above, slightly rosy tint, olivene slightly weathered, trace of tan clay.	8:20 - Good return.
220	Rosy tint, ~5% clay, ~30% light colored as at 210'.	8:32 - Good return.
223		
225	At ~226', SILTY SANDY (well graded) fine gravel up to 3/8", dry, orange. 110-foot interbed.	8:45 - Good return.
230		9:15 - Good return.
232	Total Depth @ 232', 9:17 10/3/94.	

Figure C-27. Boreholl Log 10 V, Sheet 7.

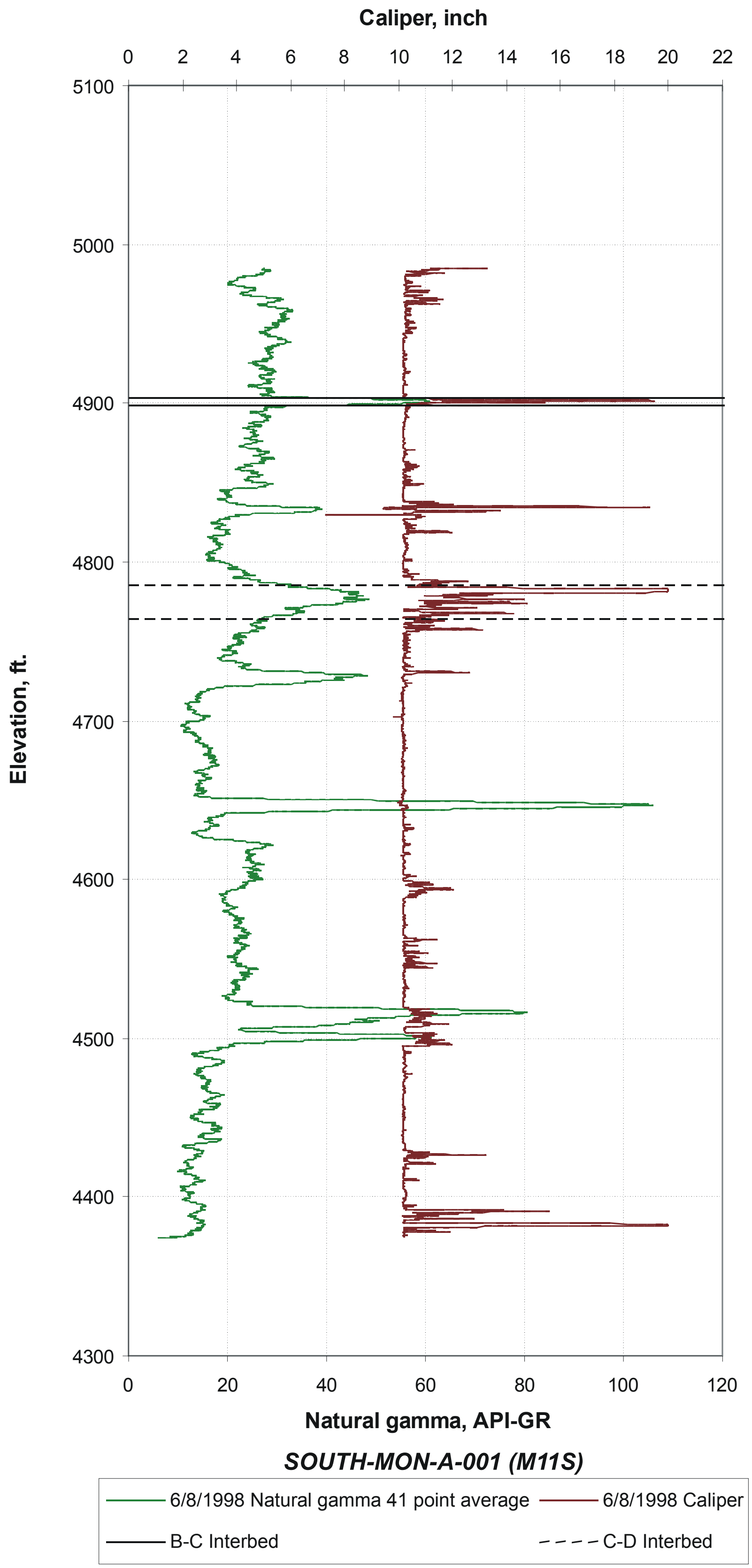


Figure C-28. Well SOUTH-MON-A-001 (M11S).

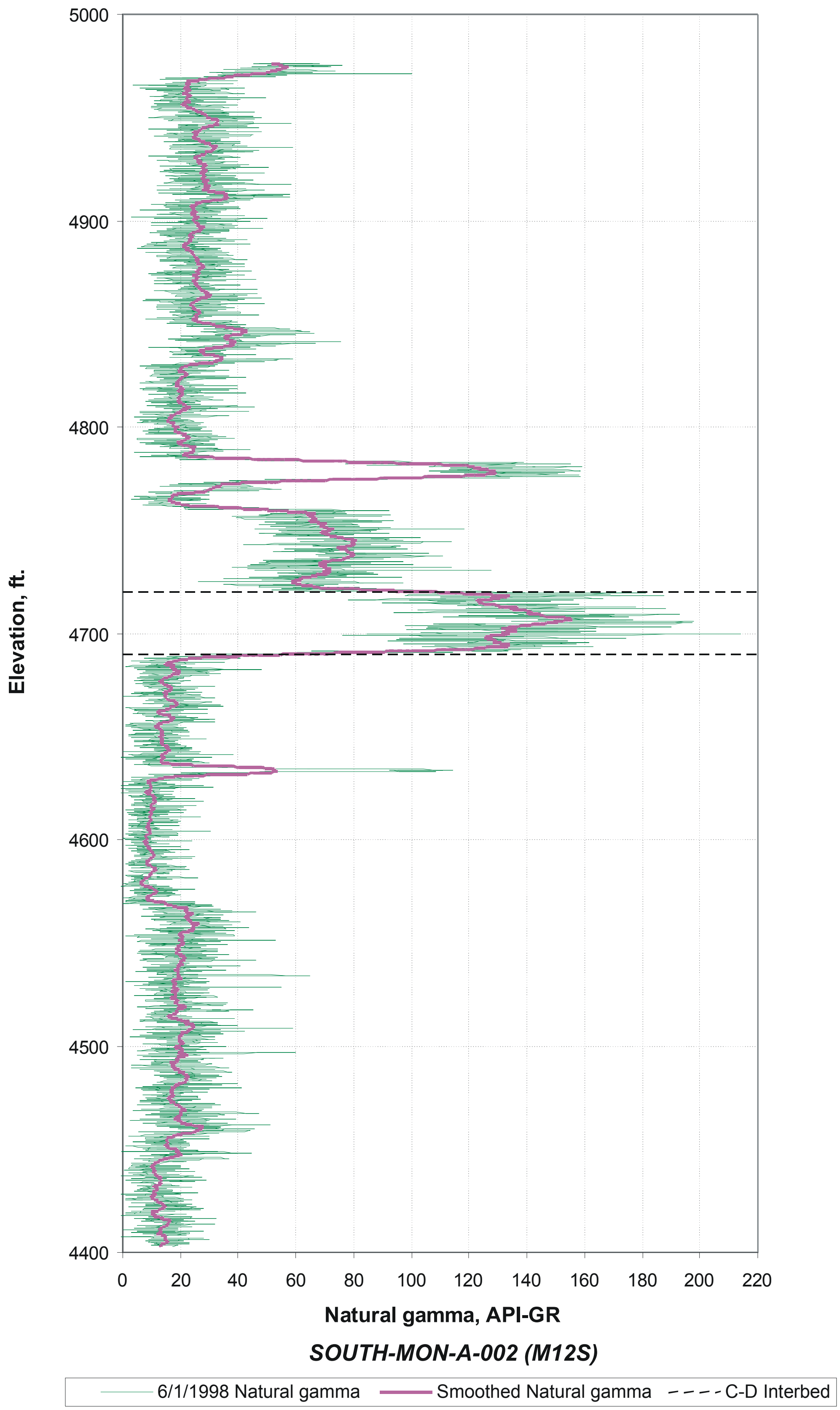


Figure C-29. Well SOUTH-MON-A-002 (M12S).

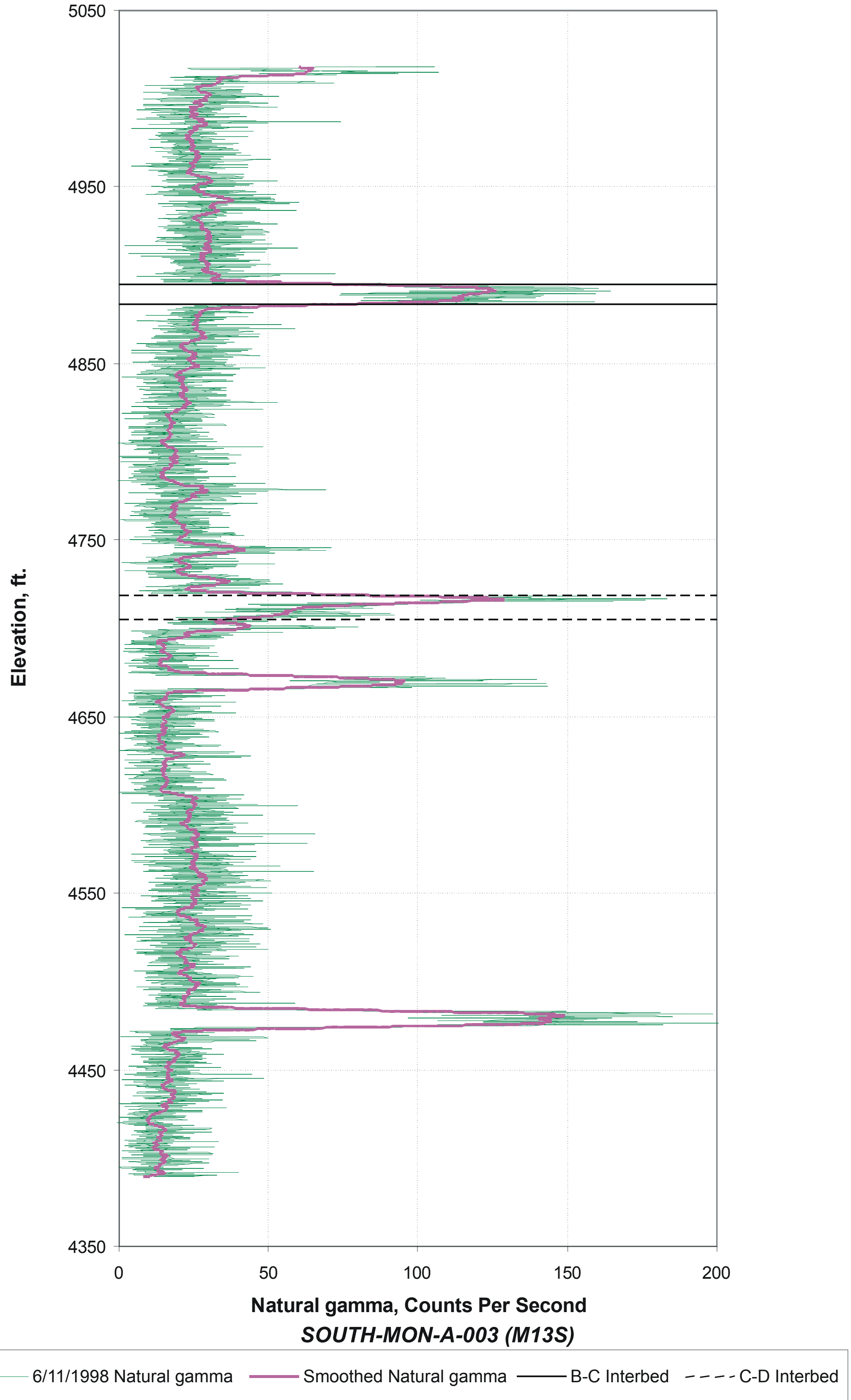


Figure C-30. Well SOUTH-MON-A-003 (M13S).

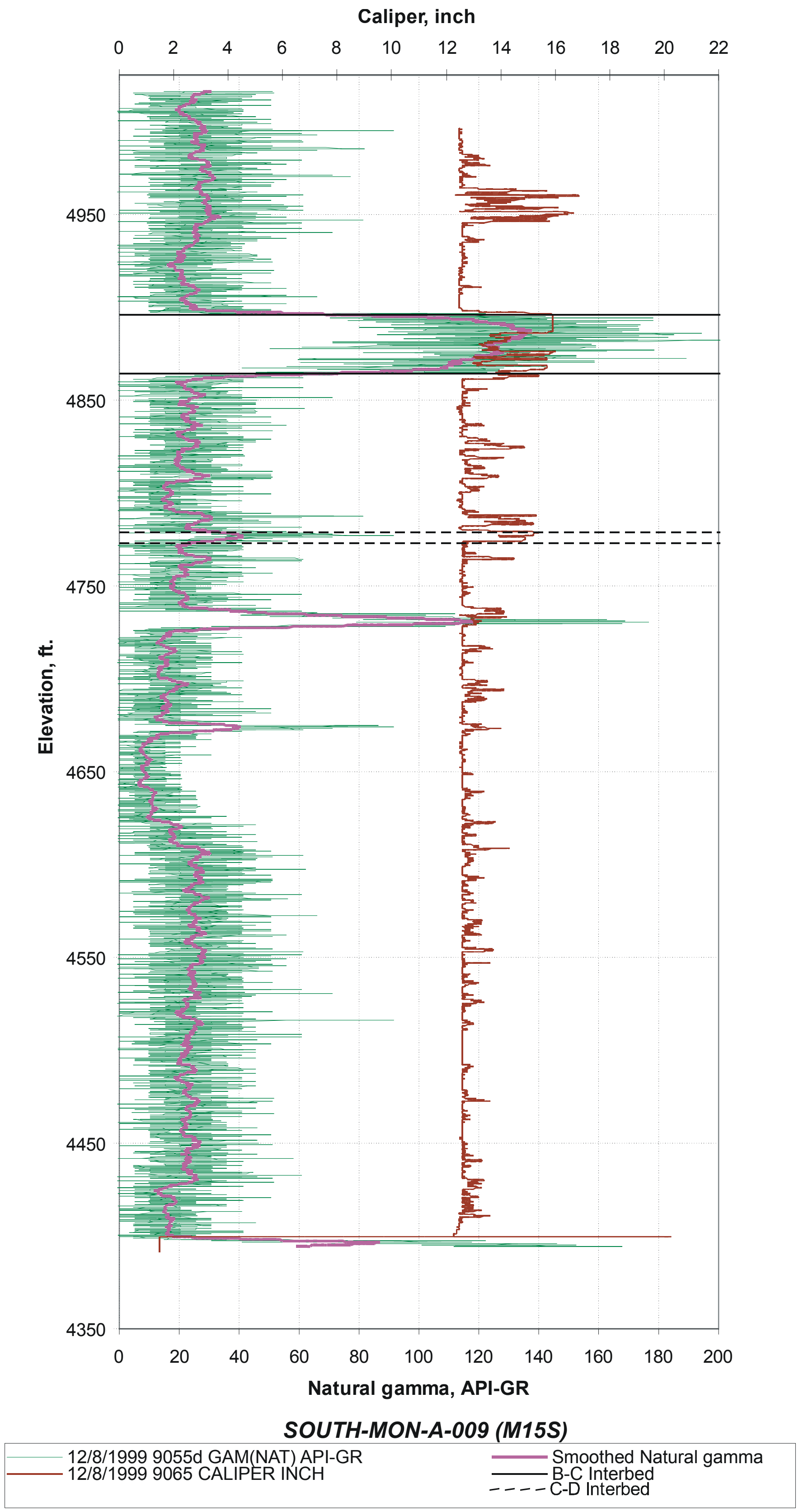


Figure C-31. Well SOUTH-MON-A-009 (M15S).

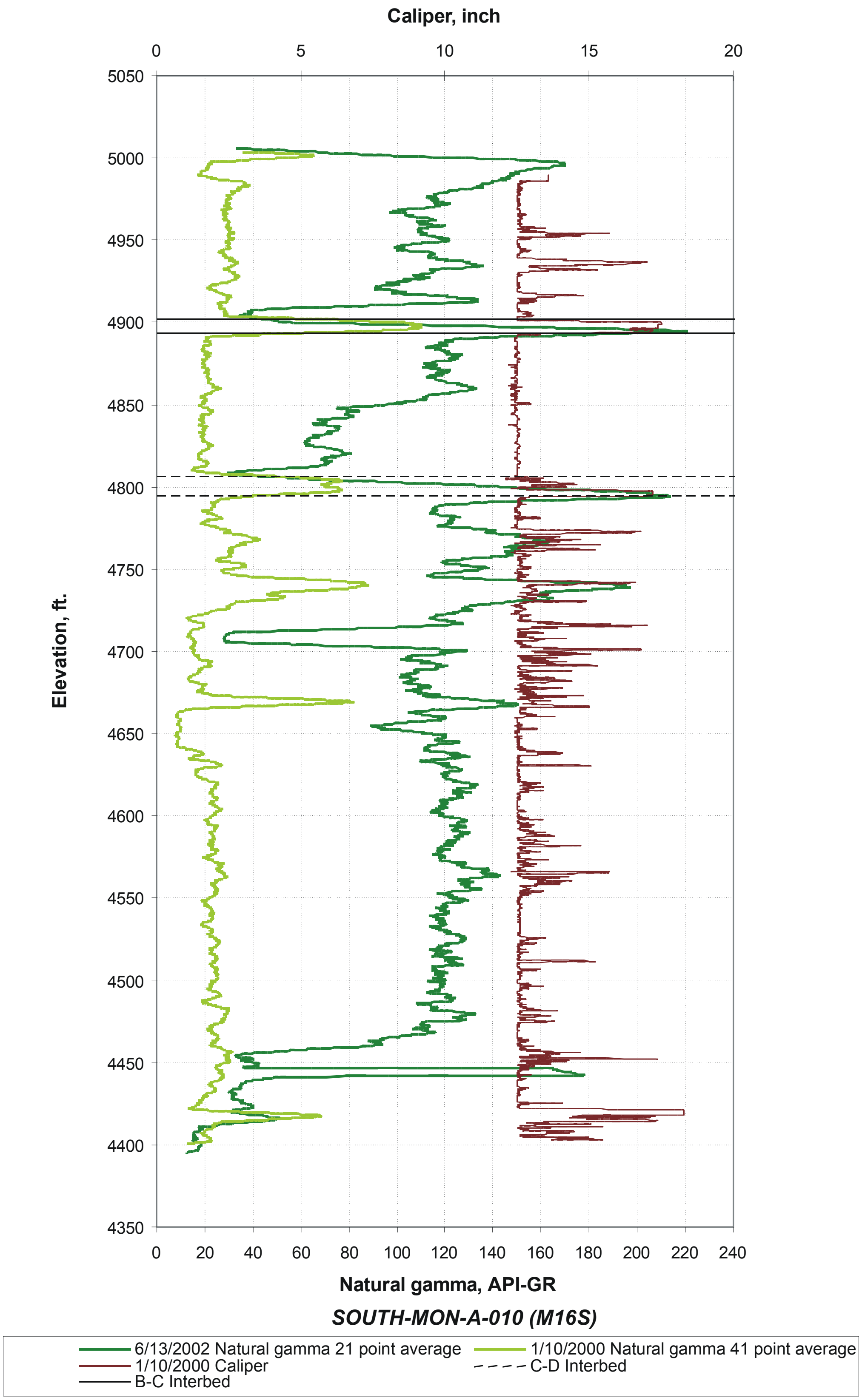


Figure C-32. Well SOUTH-MON-A-010 (M16S).

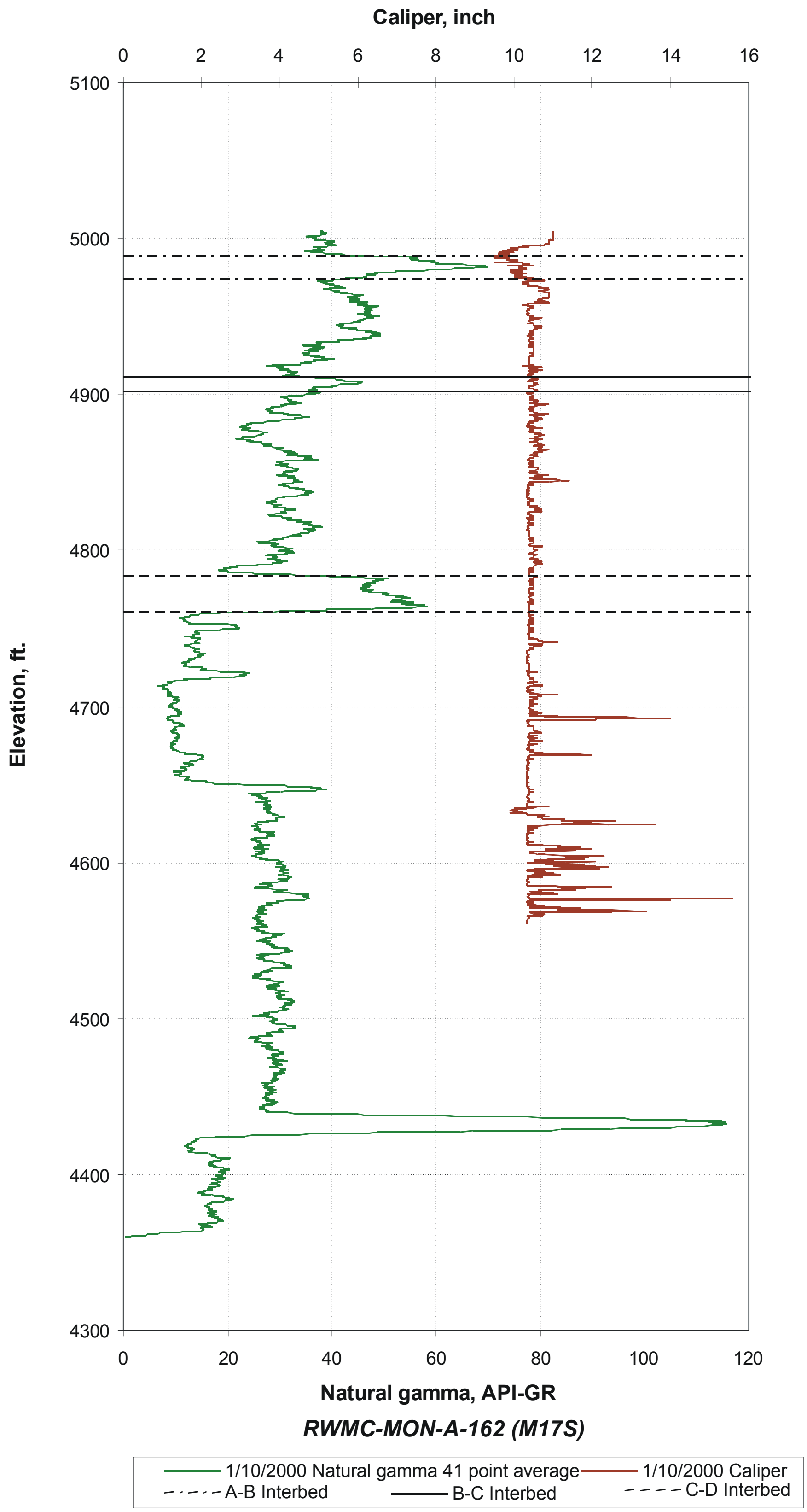


Figure C-33. Well RWMC-MON-A-162 (M17S).

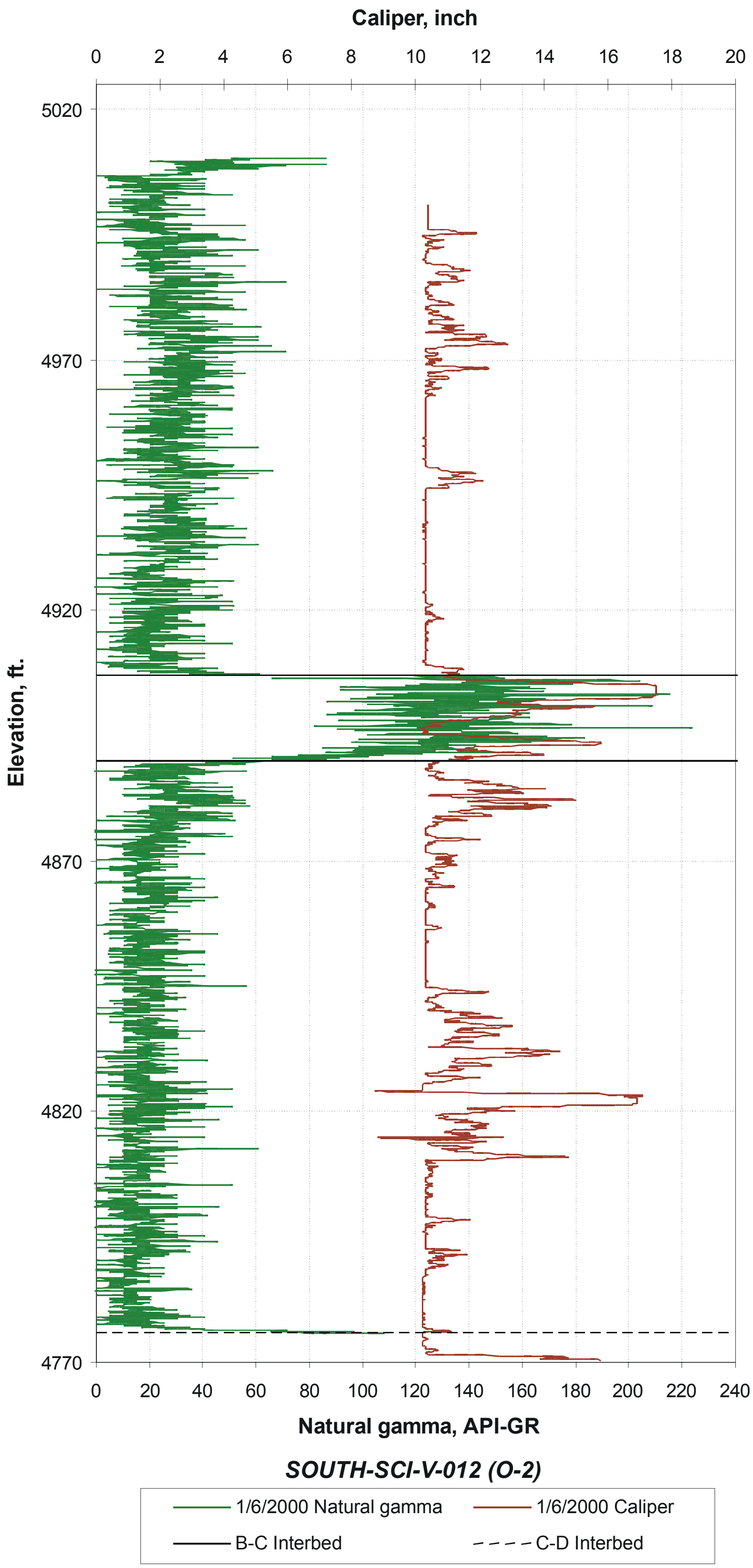


Figure C-34. Well SOUTH-SCI-V-012 (O-2).

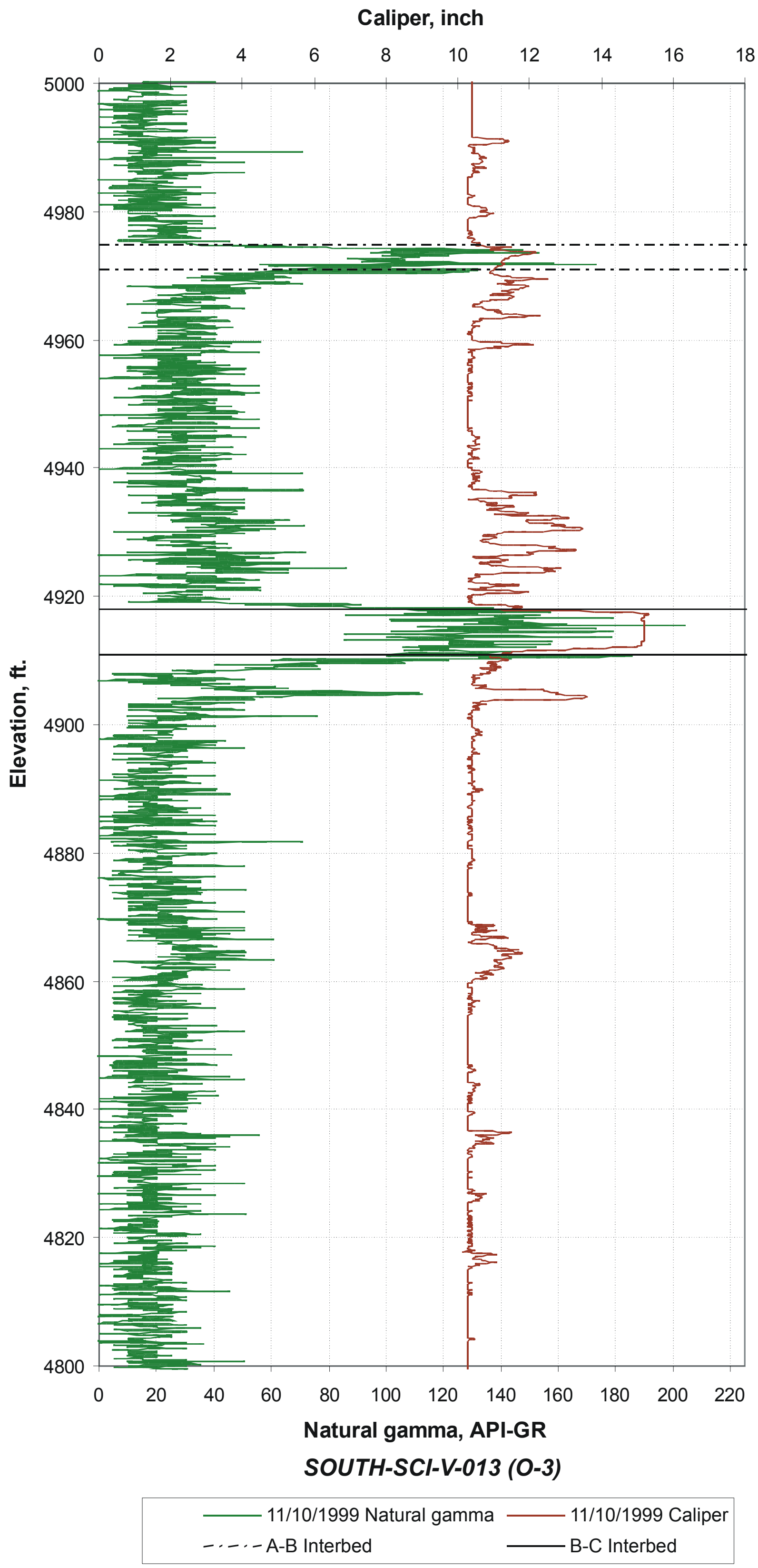


Figure C-35. Well SOUTH-SCI-V-013 (O-3).

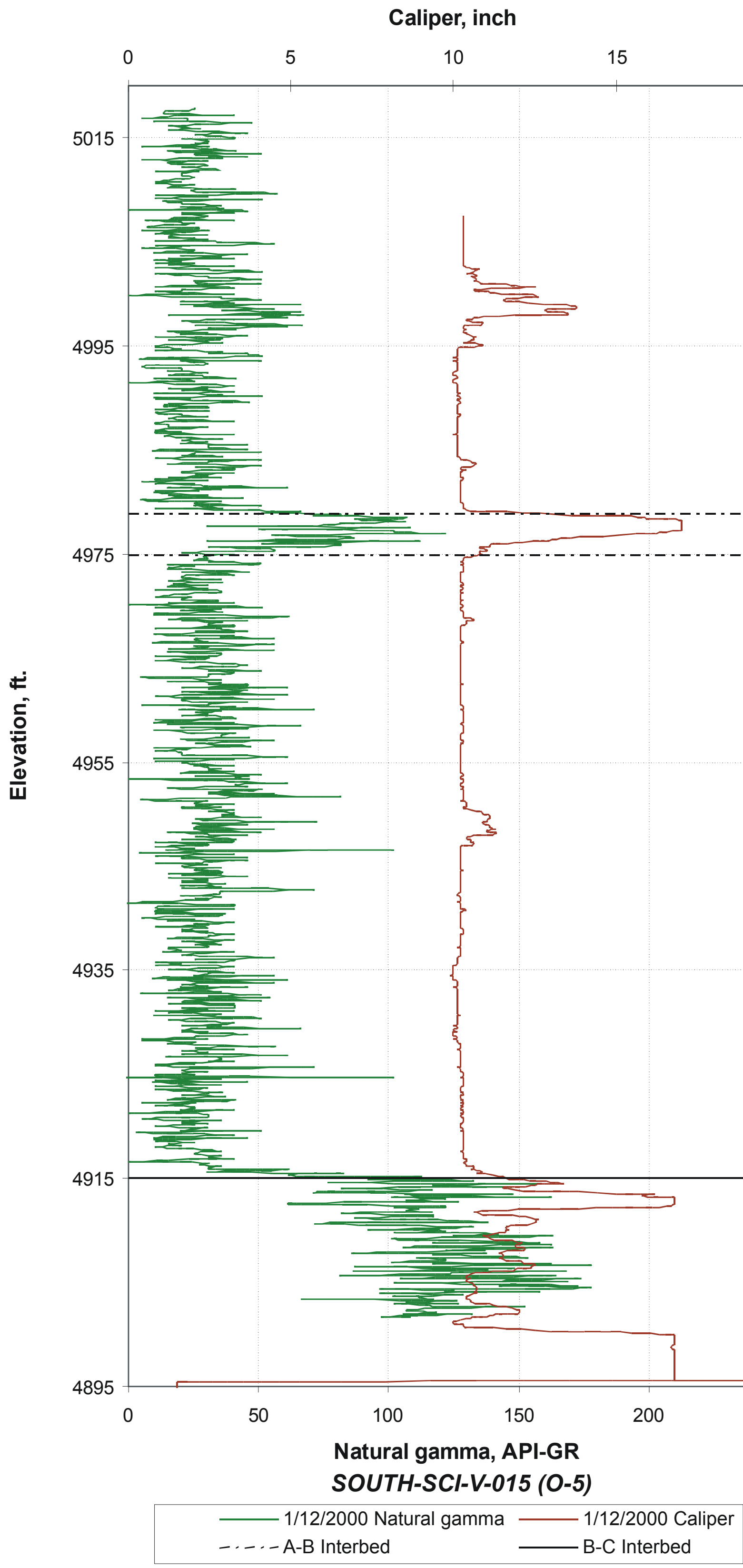


Figure C-36. Well SOUTH-SCI-V-015 (O-5).

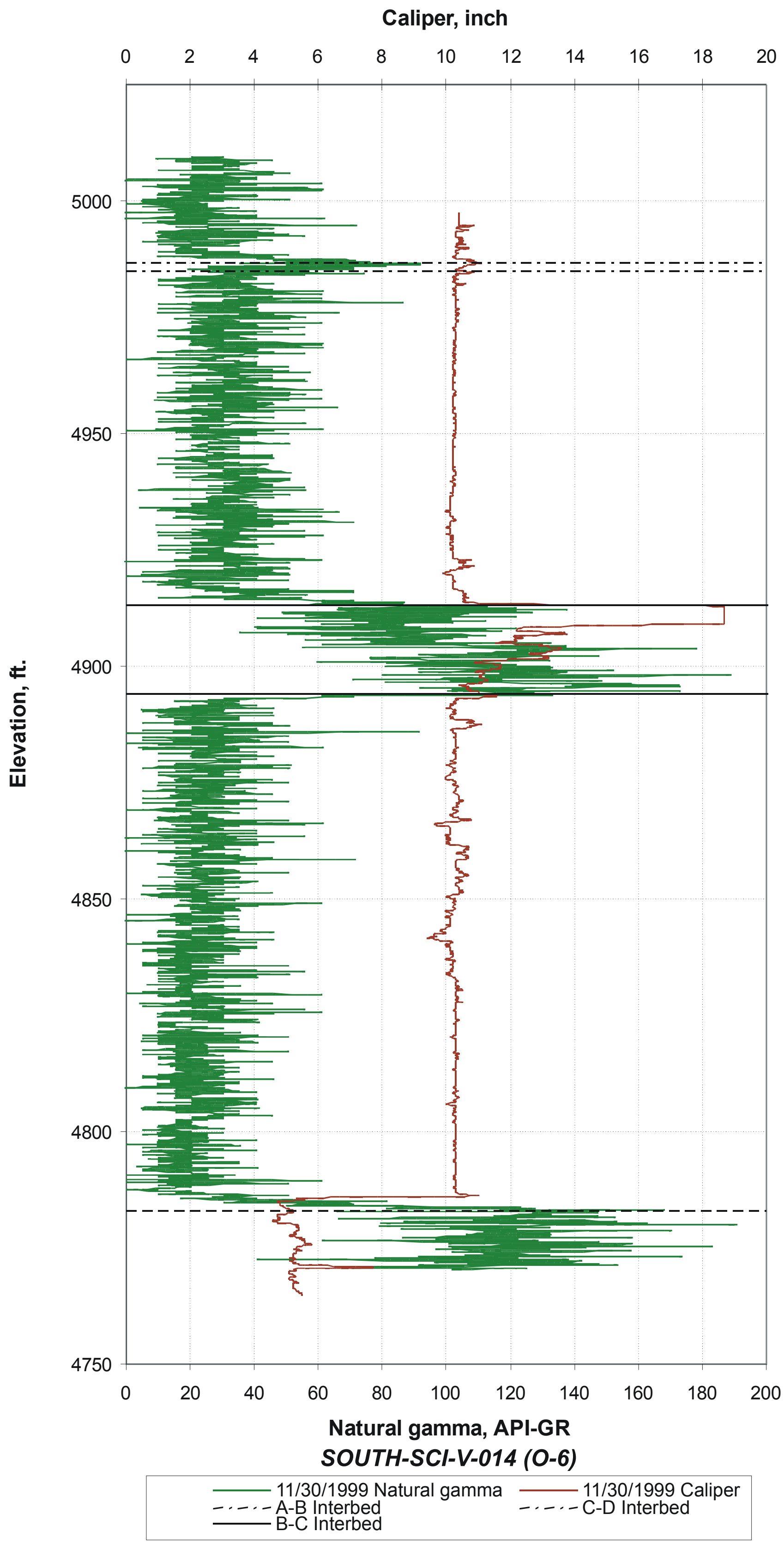


Figure C-37. Well SOUTH-SCI-V-014 (O-6).

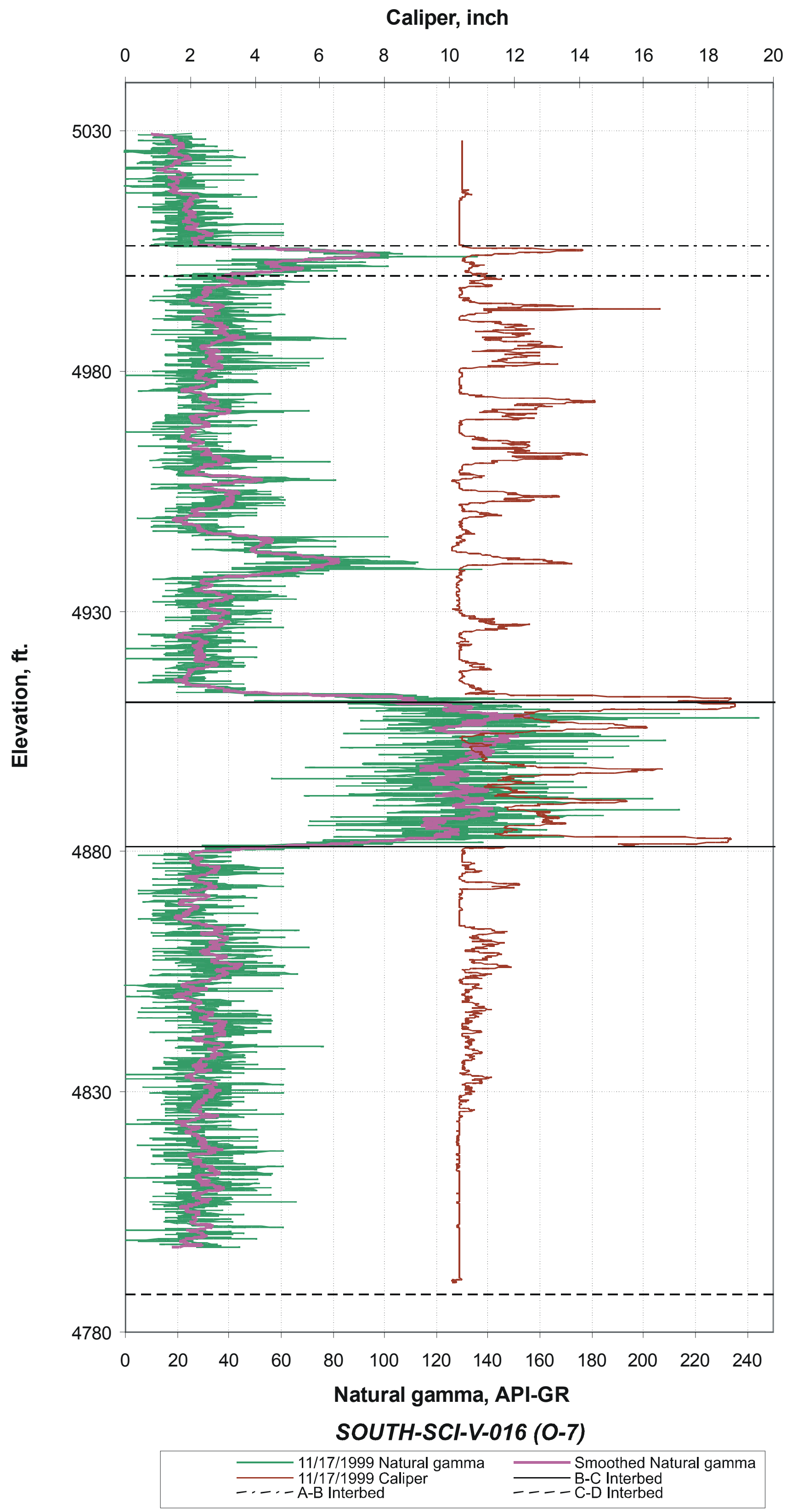


Figure C-38. Well SOUTH-SCI-V-016 (O-7).

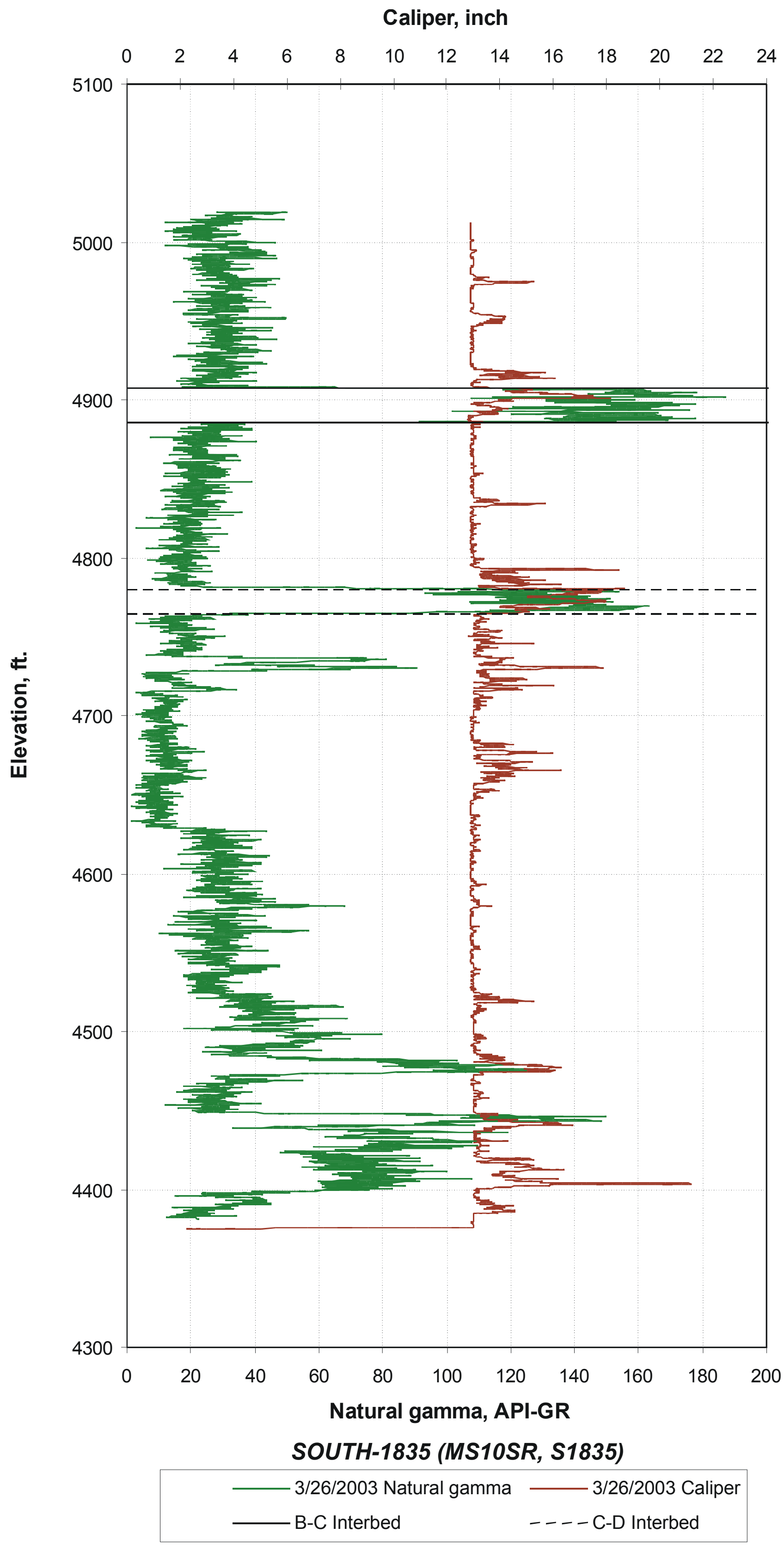


Figure C-39. Well SOUTH-1835 (MS10SR, S1835).

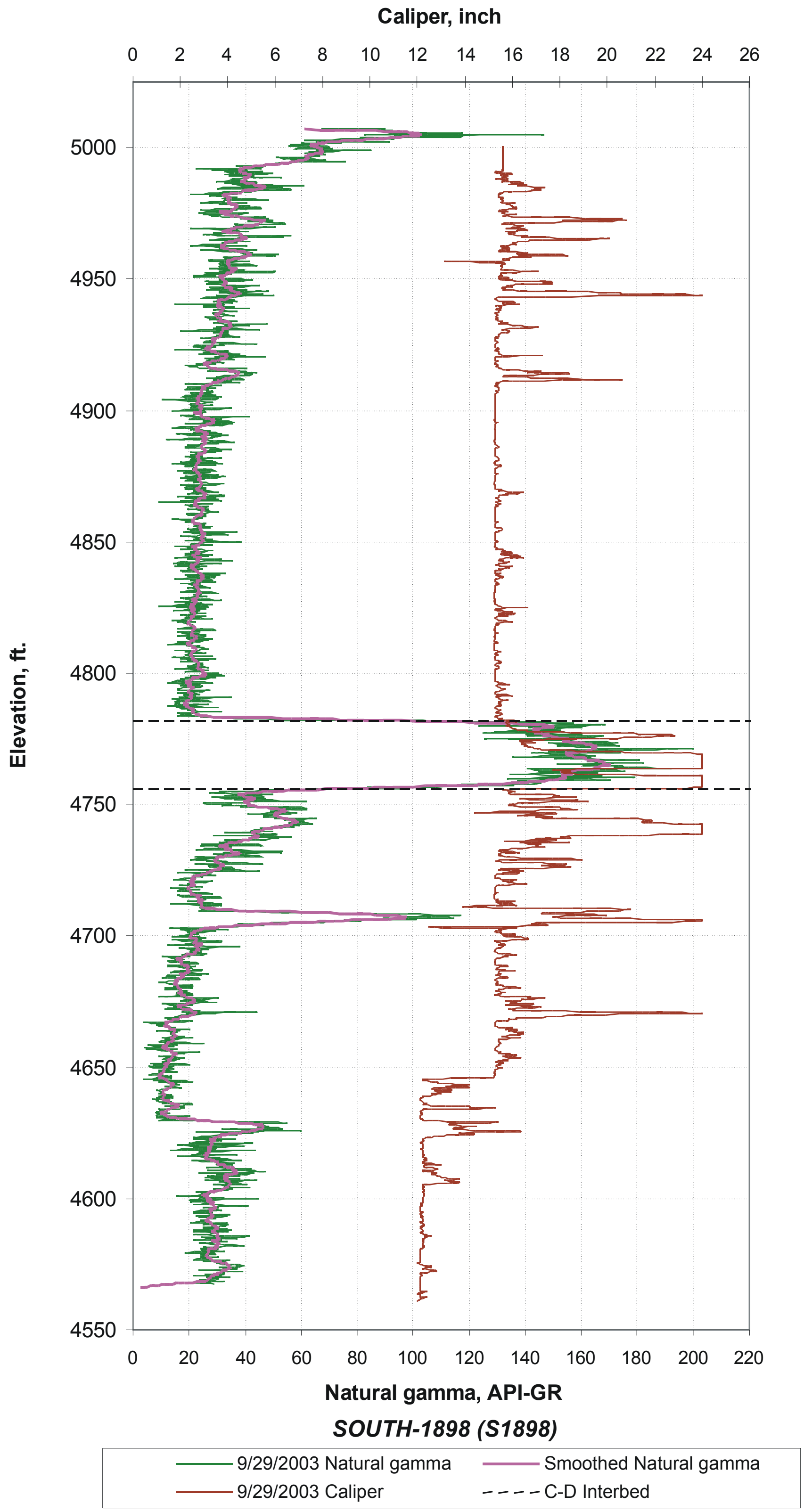


Figure C-40. Well SOUTH-1898 (S 1898).

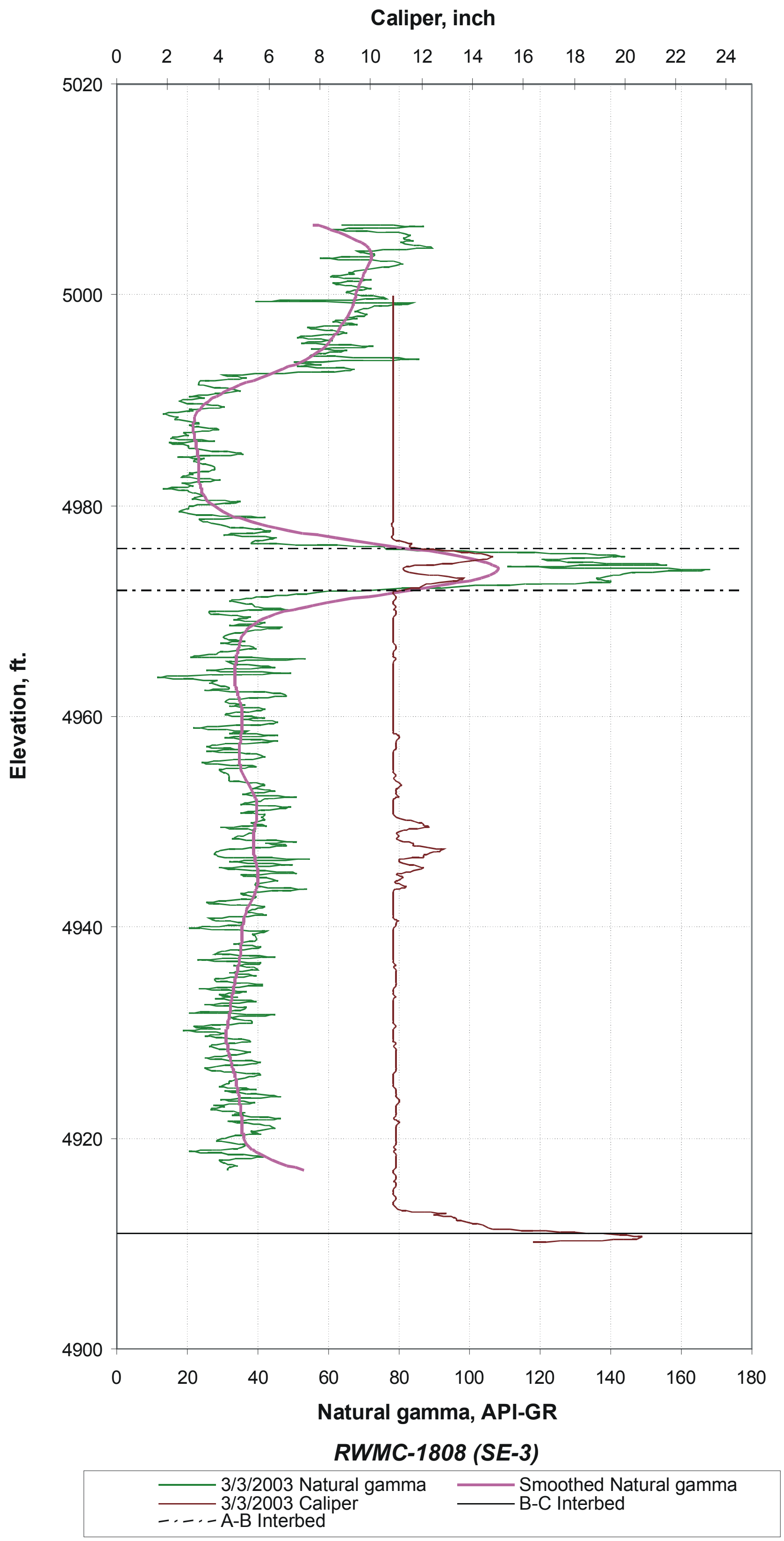


Figure C-41. Well RWMC-1808 (SE-3).

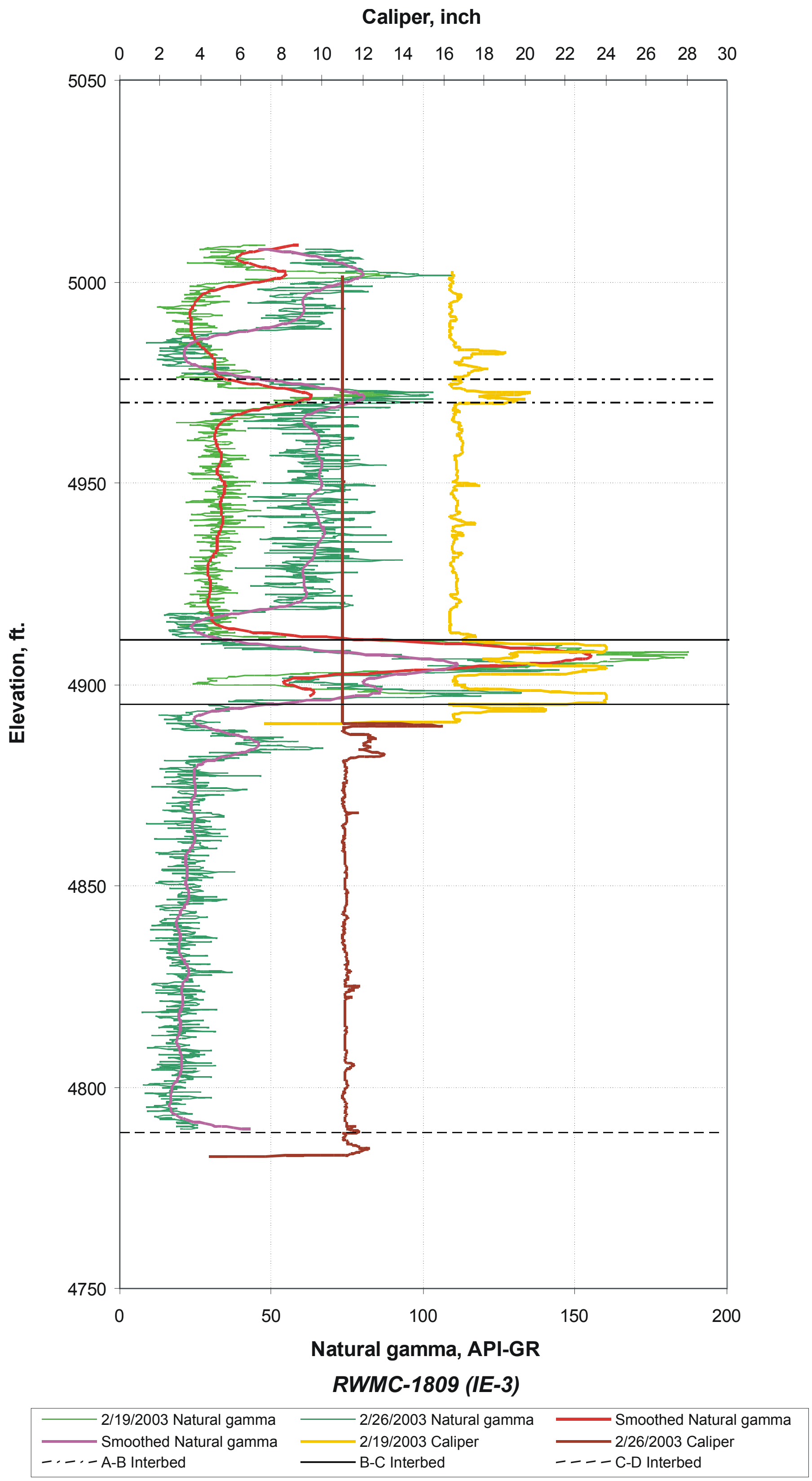


Figure C-42. Well RWMC-1809 (IE-3).

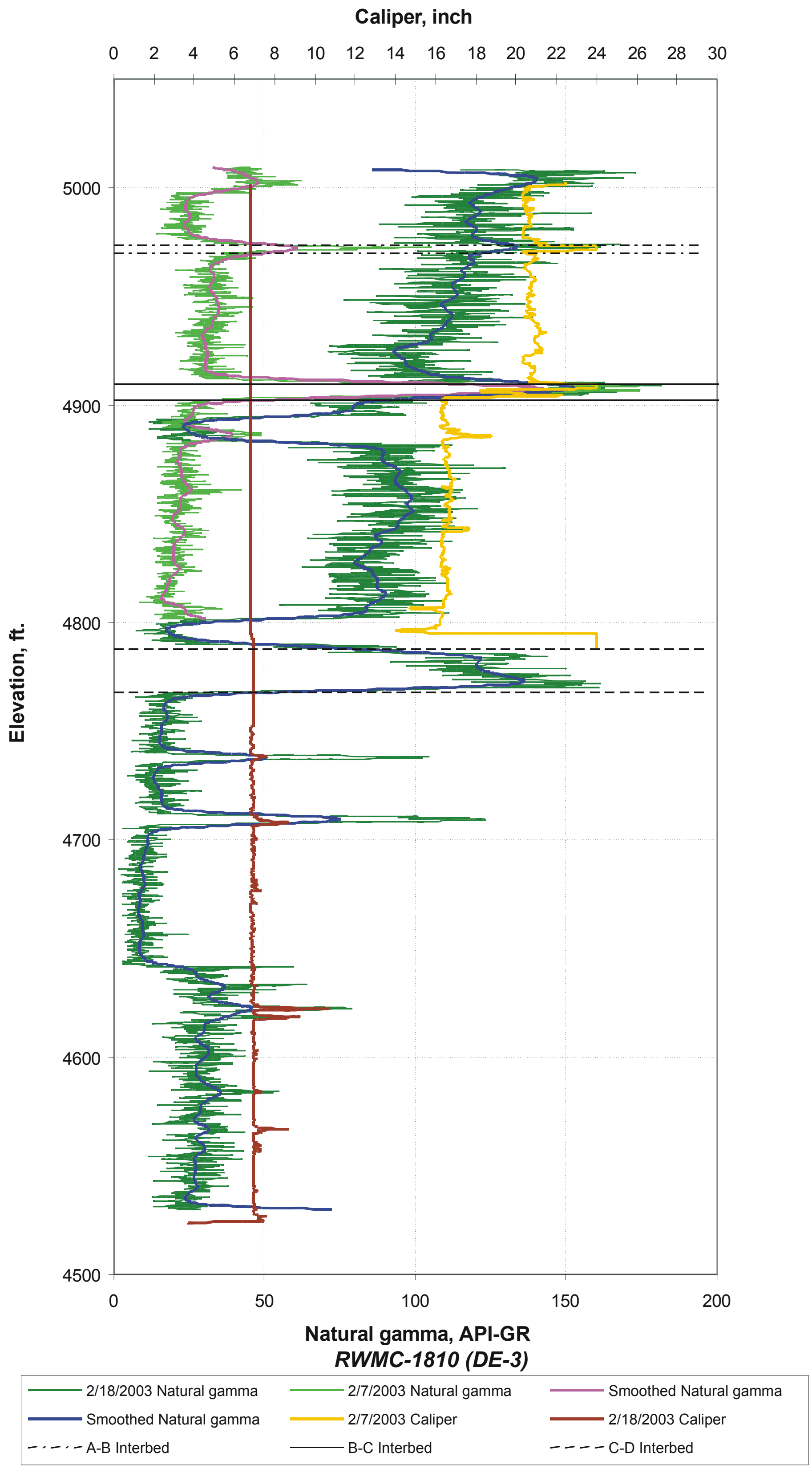


Figure C-43. Well RWMC-1810 (DE-3).

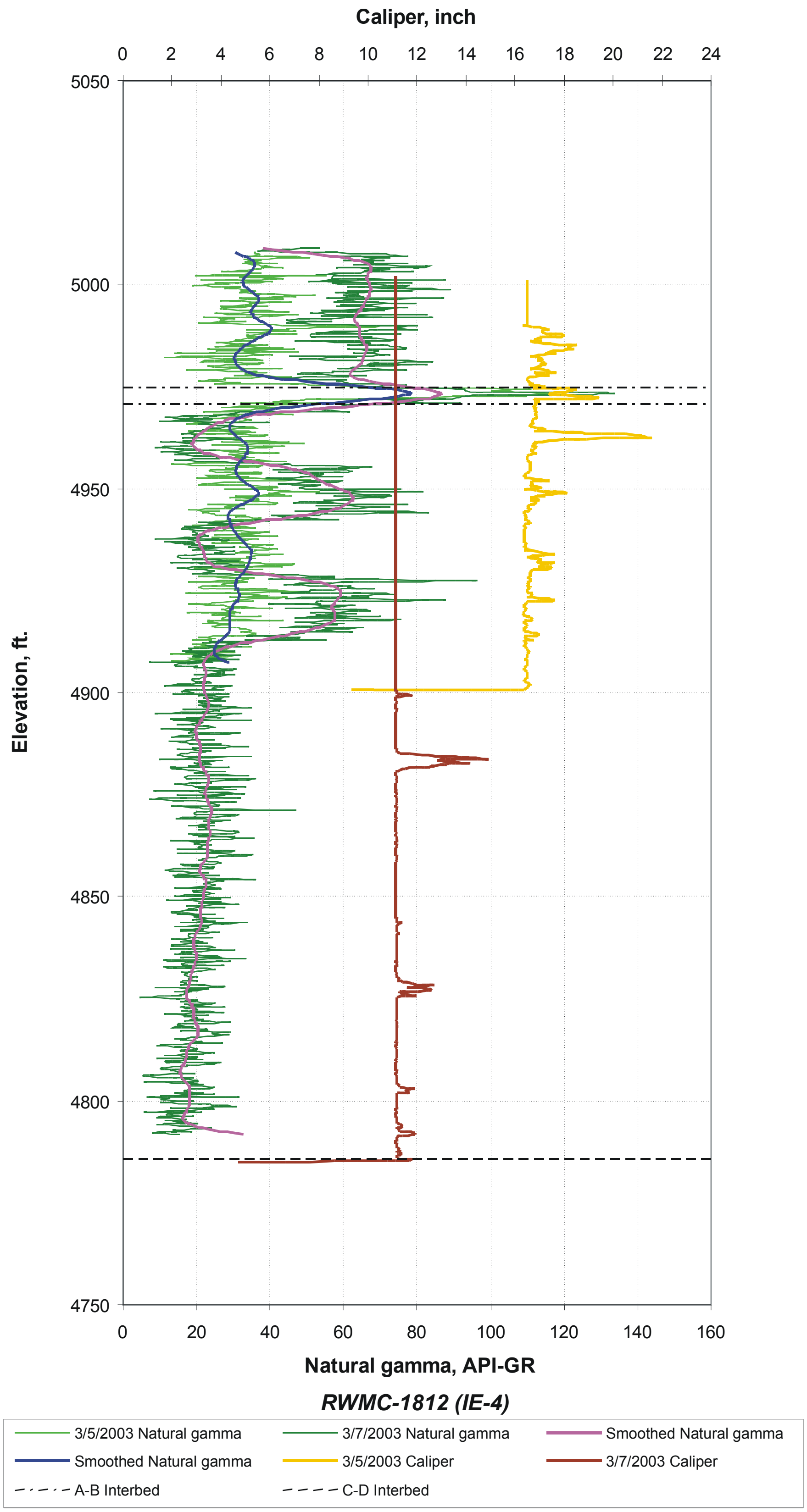


Figure C-44. Well RWMC-1812 (IE-3).

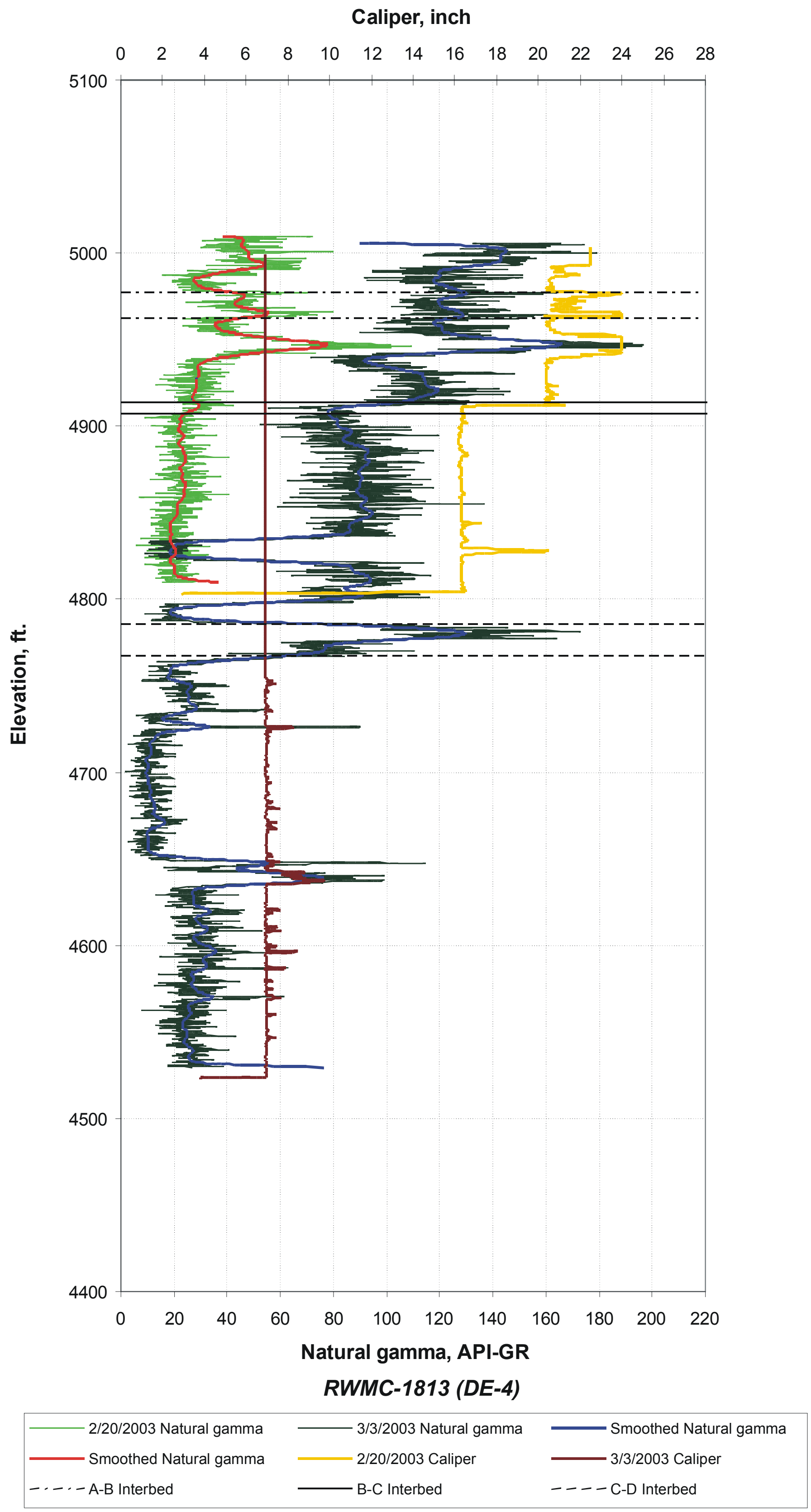


Figure C-45. Well RWMC-1813 (DE-3).

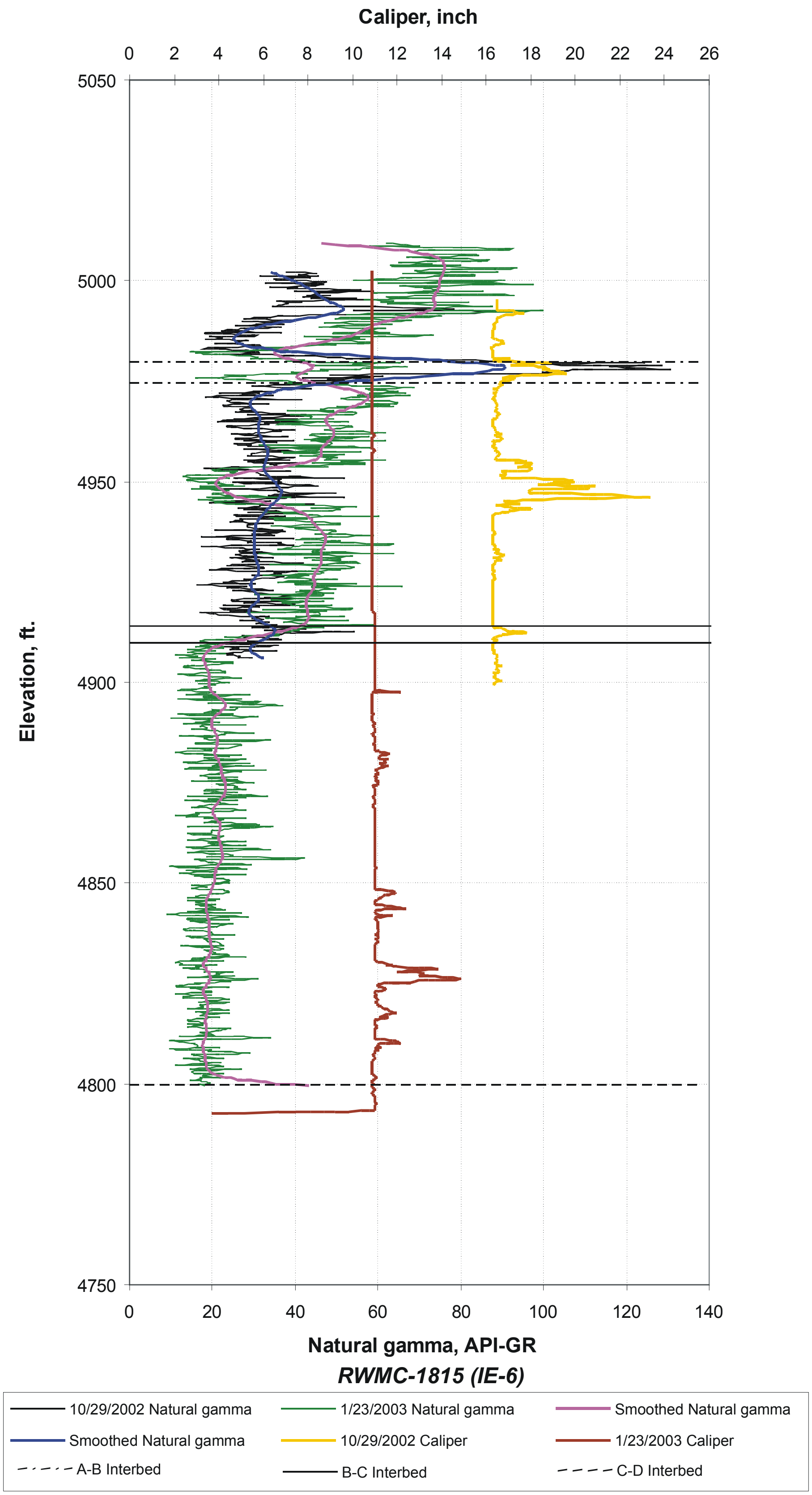


Figure C-46. Well RWMC-1815 (IE-6).

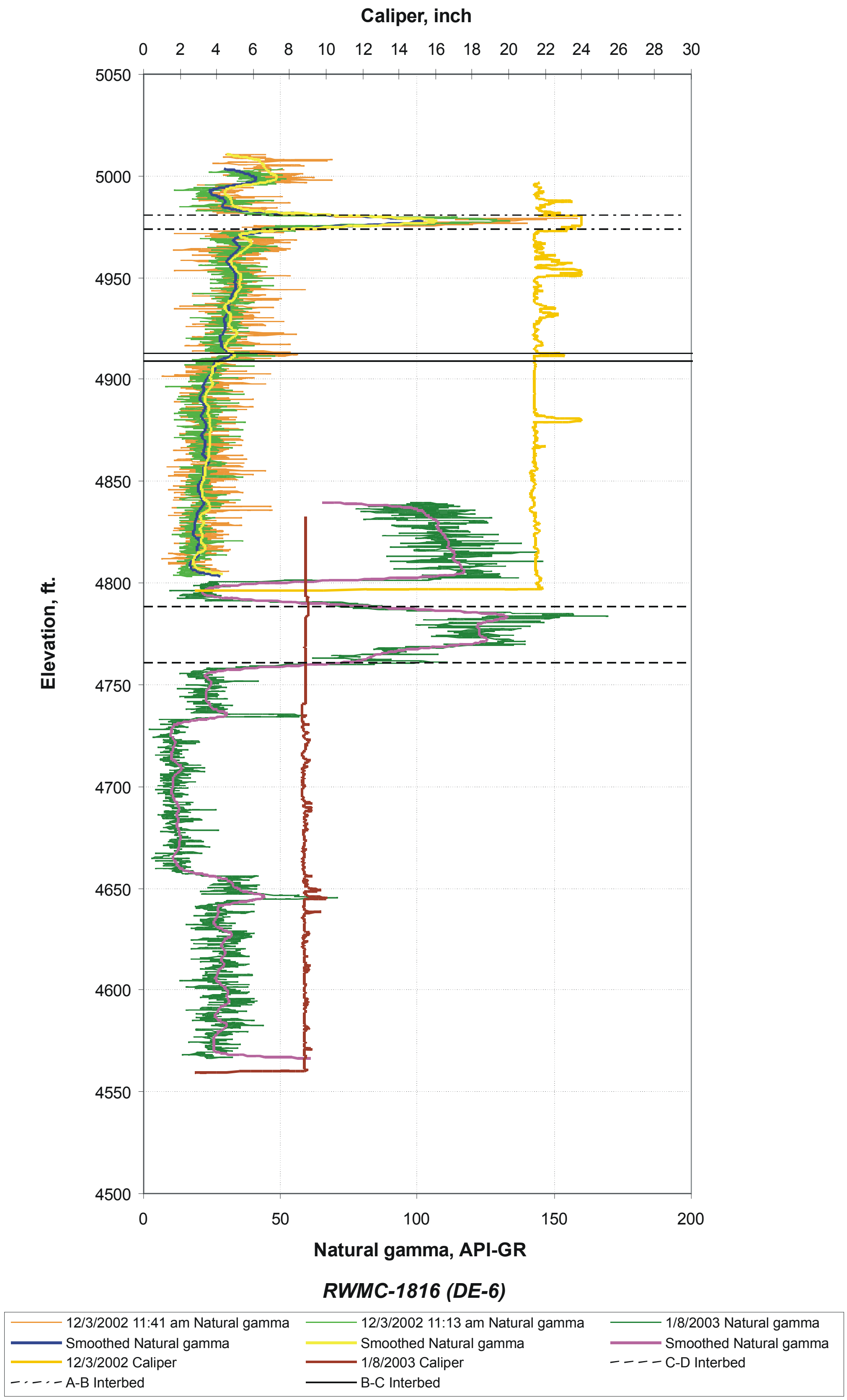


Figure C-47. Well RWMC-1816 (DE-6).

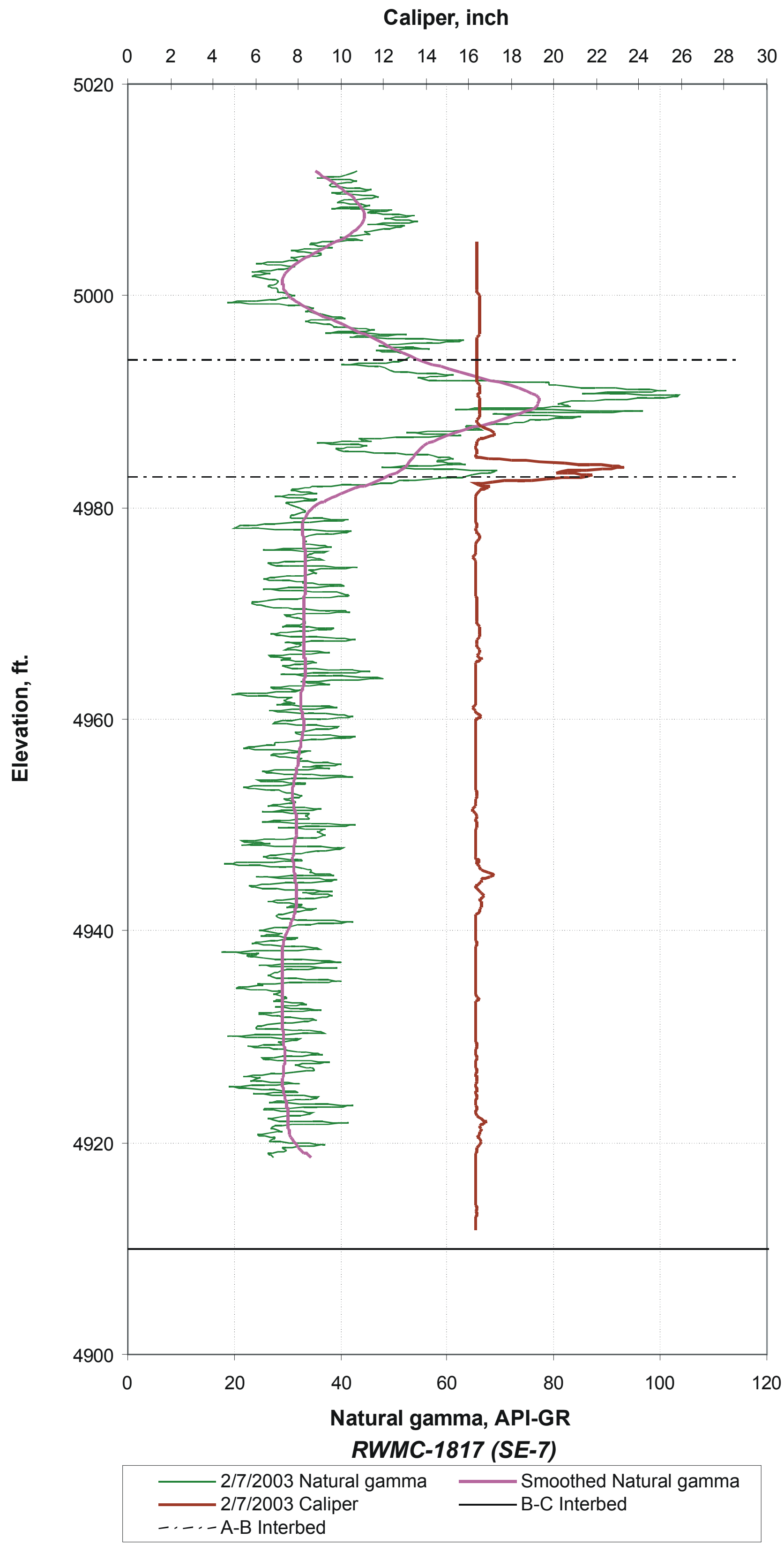


Figure C-48. Well RWMC-1817 (SE-7).

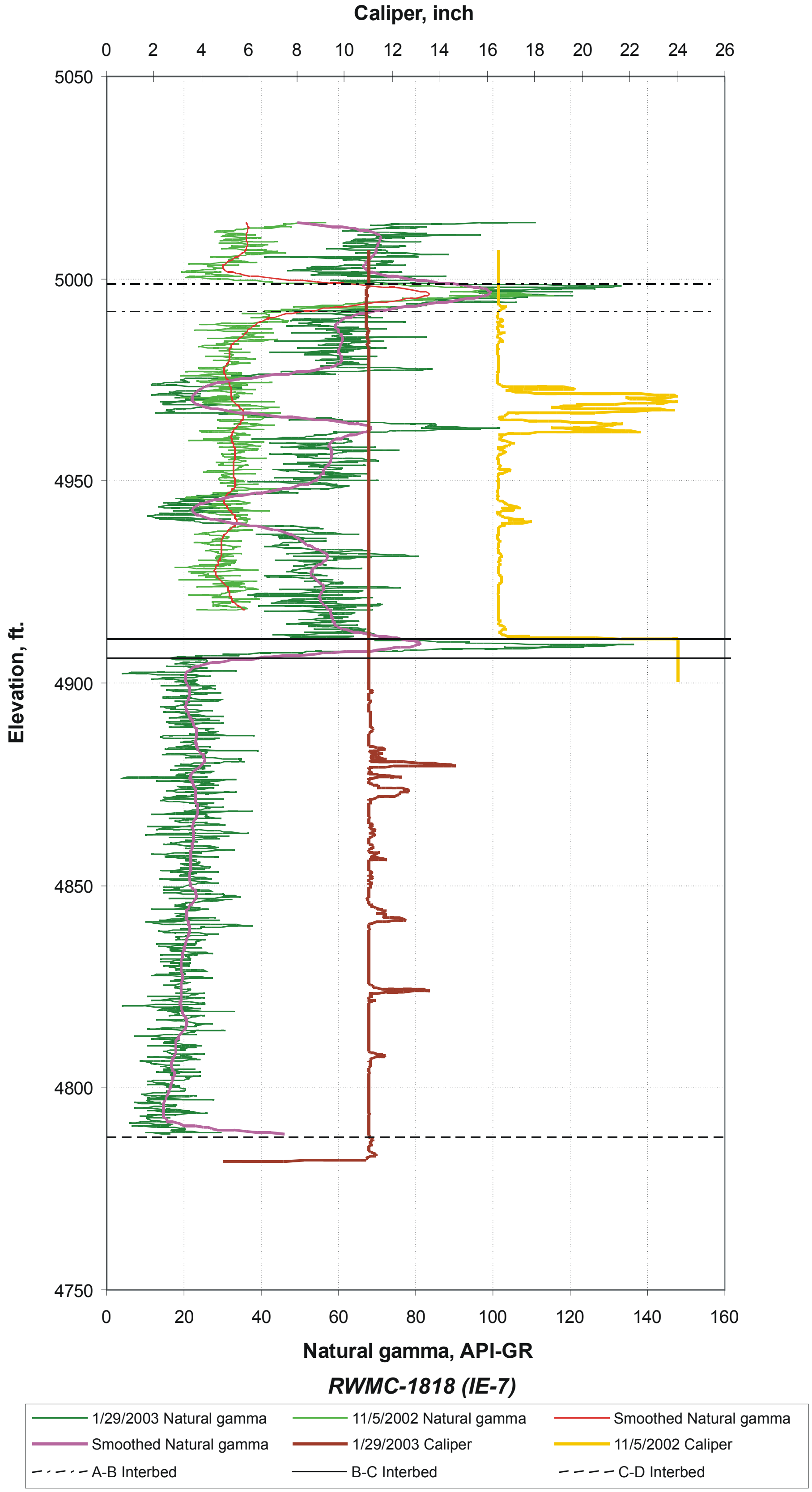


Figure C-49. Well RWMC-1818 (IE-7).

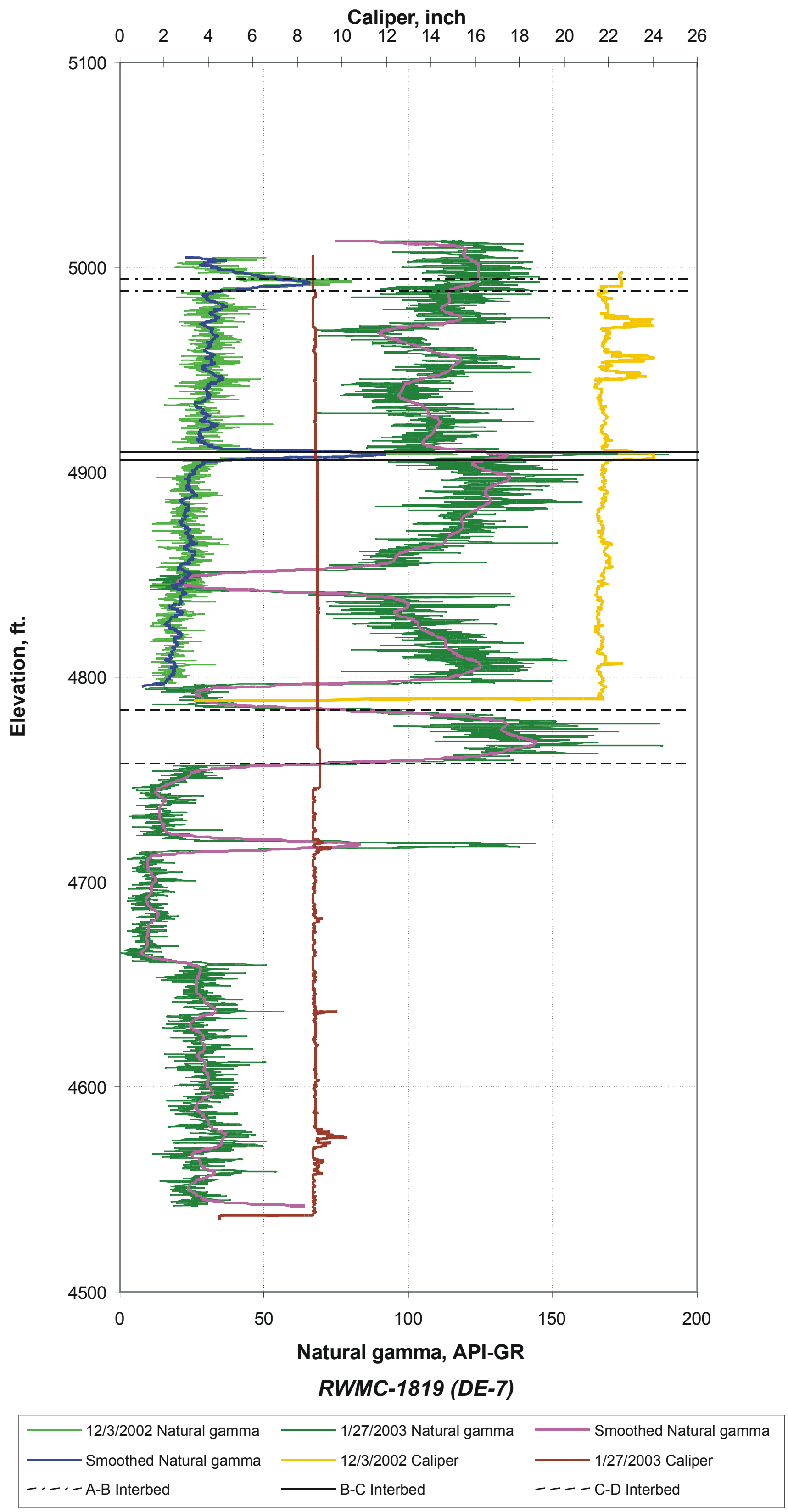


Figure C-50. Well RWMC-1819 (DE-7).

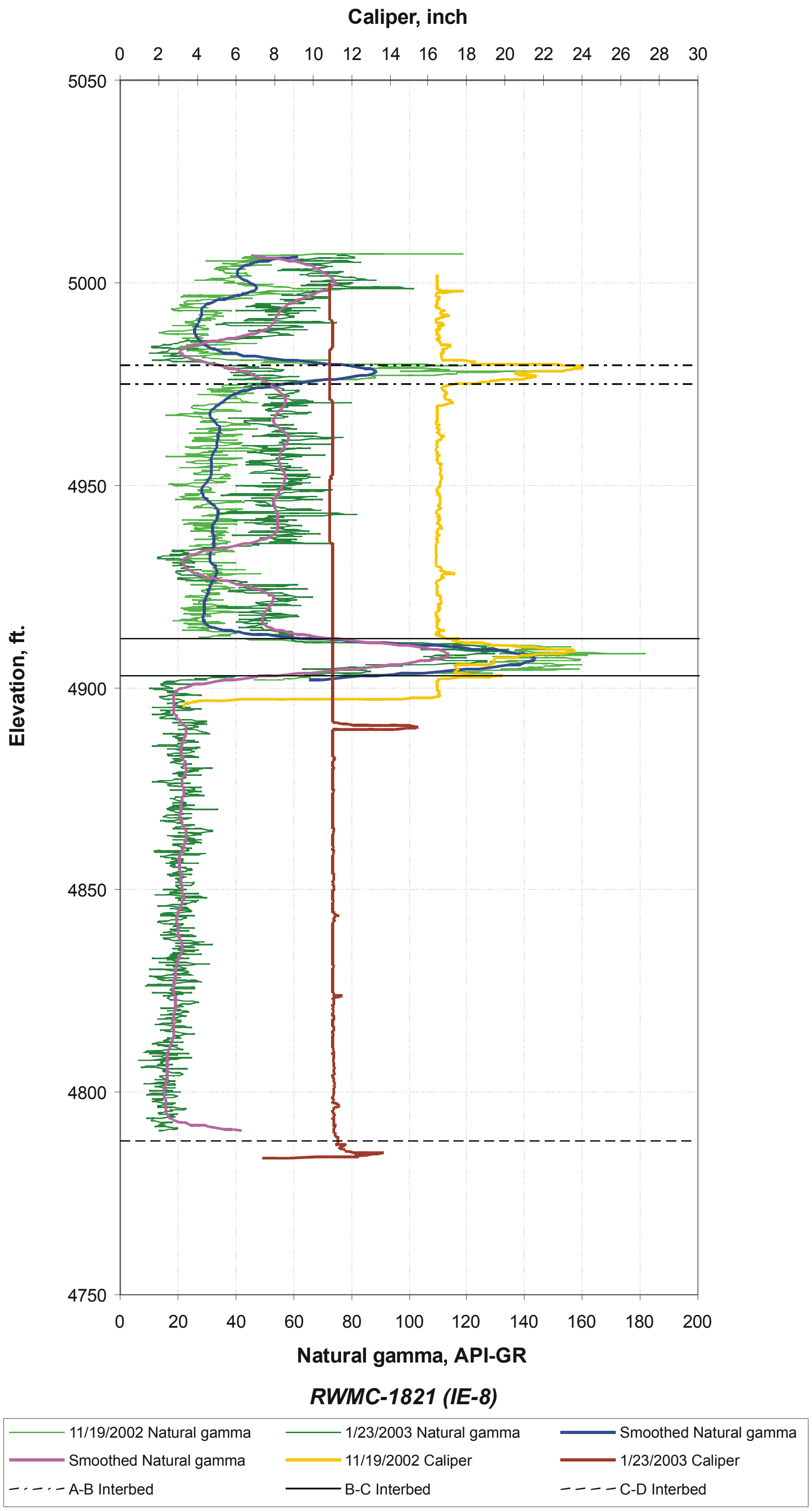


Figure C-51. Well RWMC-1821 (IE-8).

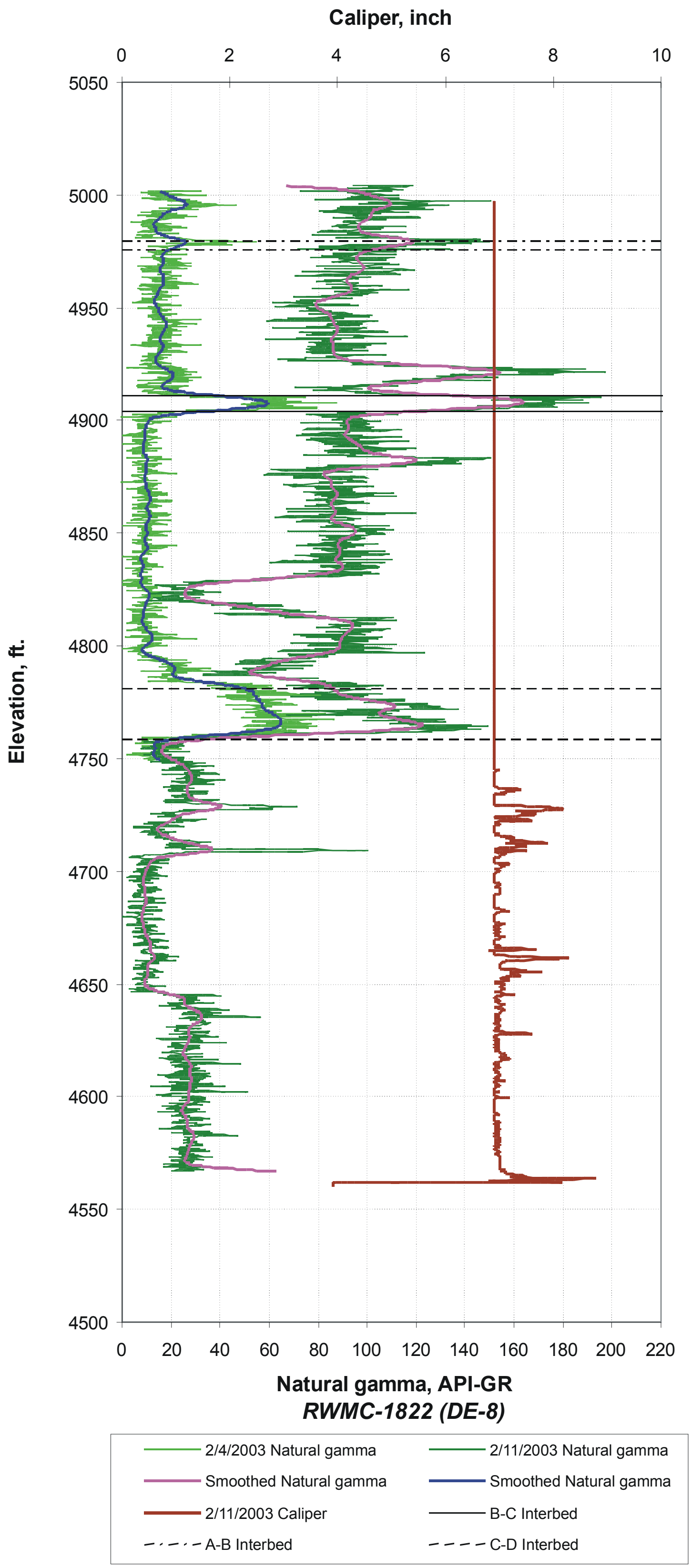


Figure C-52. Well RWMC-1822 (DE-8).

Appendix D
Well Completion Diagrams for Wells in the Vicinity of the Subsurface Disposal Area

Appendix D
Well Completion Diagrams for Wells in the Vicinity of the Subsurface Disposal Area

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